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H.A. Waite

University of Nebraska - Lincoln

E.C. Reed

University of Nebraska - Lincoln

D.S. Jones Jr.

University of Nebraska - Lincoln

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GROUND WATER IN THE REPUBLICAN RIVER BASIN IN NEBRASKA

PART III

RED WILLOW AND
FRONTIER COUNTIES

H.A. Waite, E.C. Reed and D.S. Jones, Jr.

NEBRASKA WATER RESOURCES SURVEY
WATER SUPPLY PAPER 1

The UNIVERSITY OF NEBRASKA
Conservation and Survey Division

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GROUND WATER IN THE REPUBLICAN
RIVER BASIN IN NEBRASKA

by H. A. Waite, E. C. Reed and D. S. Jones, Jr.

In June, 1939, a comprehensive test-drilling program in the Republican River basin in Nebraska was begun by the Federal Geological Survey in cooperation with the Conservation and Survey Division of the University of Nebraska. The cooperative investigation has been carried on by personnel of the State and Federal agencies working under the general supervision of G. E. Condra, Dean and Director of the Conservation and Survey Division, Wardner G. Scott, State Engineer of Nebraska, and O. E. Meinzer, Geologist in charge, Division of Ground Water, U. S. Geological Survey. Much of the field work has been under the immediate direction of G. E. Condra, the late R. C. Cady, of the Federal Geological Survey, E. C. Reed, Associate State Geologist, and part of the work from 1942 until the present was supervised by Dan S. Jones, Jr., Assistant Chief of the Bureau of Irrigation, Water Power, and Drainage of the Nebraska Department of Roads and Irrigation and H. A. Waite, of the Federal Geological Survey. In 1942, the Nebraska Bureau of Irrigation entered into an agreement with the Conservation and Survey Division to participate in the cooperative ground-water program and assumed responsibility for the drilling program in the western half of the area.

During the course of the investigation, test holes were drilled in Nuckolls, Webster, Franklin, Harlan, Furnas, Red Willow, Hitchcock, Dundy, Chase, Hayes, and Frontier counties. Two portable hydraulic drilling machines, owned by the State and Federal Geological Surveys were used in the test-drilling. The drilling machines were operated by the following personnel: Howard Haworth, Harry Burleigh, Oliver Scherer, Robert Lawrence, Orville Hansen, Harry Pinneker, and Lee Cornelius, all members of the Conservation and Survey Division; and George Neill, Carl Krenzien, Joe Vance, and Harl Williamson, of the Bureau of Irrigation. The elevations of the test holes in the western part of the area were determined by instrumental levels run by V. F. Osborn and Harl Williamson of the Nebraska Bureau of Irrigation, while most of those in the eastern part were established with altimeters except a few that were estimated from U. S. Geological Survey topographic maps. Most of the field work in connection with this investigation was done during the years 1939, 1941, and 1942, but 18 test holes were drilled in 1933, 9 in 1934, and 4 in 1935.

In 1939 the test-drilling program was carefully coordinated with the investigation of the geology and ground-water resources of the Republican Valley in the southern half of Franklin, Webster, and Nuckolls counties ^{1/} and a report dealing with the cooperative drilling program in the Republican River Valley in Nebraska was prepared by H. F. Haworth. ^{2/}

Altogether 765 test holes have been drilled in the Republican River basin with the two project-owned drilling rigs. Data relative to 20 core-drill holes put down in the Republican River basin in Nebraska by the Corps of Engineers, U. S. Army, in connection with a survey for flood control of the Republican River in Colorado, Nebraska, and Kansas and 42 test holes drilled in the basin in Nebraska by the U. S. Bureau of Reclamation in connection with prospecting for suitable dam foundations at proposed reservoir sites are also included in this report by special permission of these agencies.

Microscopic examination of the cuttings obtained from the cooperative test-drilling program was made by E. C. Reed. This report has been critically reviewed by O. E. Meinzer and others of the Federal Geological Survey, by G. E. Condra, Dean and Director of the Conservation and Survey Division, of the University of Nebraska, and by Wardner G. Scott, State Engineer of Nebraska. V. F. Osborn of the Bureau of Irrigation prepared the illustrations and assembled the logs of test holes for publication. The report and logs were typed by Miss Bernice Lundeen.

This report is designed to make available as much information as possible on ground-water conditions in the Republican River basin in Nebraska. The data herein assembled include three types of information (1) the records of test holes drilled in the county, (2) a map of the county showing (a) the locations and numbers of all of the test holes, (b) the contour of the top of the impervious bed-rock platform and (c) the thickness of the water-saturated sand and gravel formations in the valley

^{1/} Cady, R. C., Geology and ground-water resources of the Republican Valley in the southern half of Franklin, Webster, and Nuckolls counties: (To be published as a U. S. Geol. Survey Water-Supply Paper.)

^{2/} Haworth, Howard F., Drilling program in the Republican River Valley (1939) 24 pp., 12 figs., 1939. (In manuscript form on file in the office of the Conservation and Survey Division, Lincoln, Nebraska, and in the office of the Division of Ground Water, Geological Survey, Washington, D. C.)

bottom land and terrace region, shown by means of shaded patterns on the county map, and (3) a geologic profile section in each county based on the test-drilling information. The description of materials drilled in the test holes is in driller's terminology and does not constitute, necessarily, an exact geologic description.

Interested parties can make use of these data advantageously in the following manner: The probable nature and thickness of materials underlying a specific piece of land can be approximated by studying the shaded areas on the map and by examining the logs of nearby test holes drilled in similar topographic positions, keeping in mind differences in surface elevation. If the land is situated in the upland outside of the valley, logs of nearby upland test holes can be used as a guide, provided that allowances are made for differences in surface elevation and variations in texture and slope of the water-bearing material.

The maps may be used in the following manner: If the land in question is located in an area shown on the map as underlain by a relatively thin, water-filled formation, the chances of obtaining high-capacity wells are less than in areas shown as underlain by a relatively thick water-filled formation. Thus, locations on the farm may be selected that are more favorable from a water-production standpoint.

The contours on the top of the relatively impervious Cretaceous bedrock theoretically connect points of equal elevation on the top of this buried surface and thus outline buried channels where the elevations are comparatively low and buried ridges where the elevations are comparatively high. As a general rule the thickest and coarsest sands and gravels occur near the middle of the buried channels.

All ground-water information shown on the maps is based on data obtained from test drilling and is therefore more accurate for land adjacent to closely-spaced test holes and less accurate for areas where the test holes are situated farther apart.

The thicknesses of saturated water-bearing material shown on the county Ground-Water Maps have been computed from water levels measured in the test holes on the dates specified in the written logs. It is known that the water table fluctuates upward and downward depending upon the amounts of ground-water recharge and discharge. This seasonal fluctuation is usually less than a foot and rarely more than three to four feet. Therefore the thicknesses shown are probably accurate within a few feet at any time of the year.

The information included in this report is not designed to eliminate the necessity of drilling test holes prior to the installation of irrigation or other high-capacity wells, but it should be a guide toward the evaluation of possibilities. Many factors other than the thickness of the water-saturated material greatly affect the yields of the wells and the perennial supplies of ground water in any locality, including: (1) permeability of the water-bearing formation, (2) design and construction of the well and pumping equipment, (3) ease of recharge of the water-bearing formation from precipitation or from surface flow, and (4) amount, distribution and nature of precipitation and of surface flow.

If additional technical assistance and guidance is required the Conservation and Survey Division of the University of Nebraska is equipped to answer inquiries on specific problems providing location by legal description is accurately supplied.

BEDROCK FORMATIONS IN RED WILLOW AND FRONTIER COUNTIES

The surface and near-surface sediments in most of the area of Red Willow and Frontier counties consist of mantlerock materials such as (1) silty clays (loess) and (2) sands and gravels, both of which were deposited in comparatively late geologic time (Pleistocene epoch). The sands and gravels deposited by streams, and the silty clays deposited by wind action, form a mantle over the top of a relatively uneven, eroded bedrock surface. The present streams have cut through the mantlerock and exposed the underlying bedrock at a number of places, notably along the south side of the Republican Valley and along the sides of tributary stream valleys on the south side of the Valley. Bedrock has also been exposed on the north side of the Republican Valley west of McCook, along Medicine Creek in Frontier County from near Stockville southeastward to the county line, along Beaver Creek between Marion and Lebanon, and along Red Willow Creek in both Red Willow and Frontier counties, the outcrops extending northwestward along Red Willow Creek from a point about 8 miles north of McCook to a point about 3 miles north of the southwest corner of Frontier County, and into Hayes County.

Knowledge of the bedrock materials of the area has been gained by a study of the bedrock outcrops along the valley sides and the records and samples from deep wells, most of them drilled as tests for oil and gas. ^{1/}

The bedrock formations which are exposed in this area, listed in order from youngest (uppermost) to oldest (lowermost) are: the Ogallala formation of Tertiary age; and the Pierre shale and Niobrara formation, of Upper Cretaceous age. Older Cretaceous formations, which occur at depth within the area and are exposed east of the limits of this report, are the Carlile shale, Greenhorn limestone, Graneros shale, Dakota sandstone, Fuson shale and Lakota sandstone. These sedimentary rocks of Cretaceous age are underlain by a considerable thickness of older limestones, shales, sandstones, dolomites and similar types of sedimentary rocks of Permian, Pennsylvanian, Ordovician, and Cambrian age, and they in turn are underlain by igneous or metamorphic rocks.

Before the Ogallala formation of Tertiary age was deposited, the underlying Cretaceous formations were subjected to folding and then were eroded to a comparatively flat westward-sloping surface. As a result, the Ogallala in places rests on truncated Cretaceous rocks and may occur next above any part of the Pierre shale or Niobrara formation.

The Ogallala formation is made up of a series of hard and soft beds consisting of limy sandstone and siltstone interbedded with sands,

some gravel, and some clay. Certain zones are extremely dense in places where the cementing material is silica. The Ogallala formation occurs immediately below the mantlerock under a large part of the uplands in Red Willow and Frontier counties, thickening in a westward direction and cropping out along the valley sides both north and south of the Republican River. North of the Republican River, it is exposed locally in the bluffs from the edge of McCook westward for a distance of about 3 miles and in the bluffs at a point about 2.5 miles east of McCook. Scattered outcrops occur along some of the minor tributary valleys on the north side of the Republican Valley. The Ogallala is also well exposed along the valley sides of Red Willow Creek in Red Willow and Frontier counties, the outcrops extending from the southwestern part of Frontier County southeastward to a point about 8 miles north of McCook. In Frontier County, the Ogallala is exposed along both sides of Medicine Creek from near Stockville southeastward to the Frontier-Red Willow-Furnas county line.

South of the Republican River the Ogallala formation crops out along the valley sides of small streams tributary to Driftwood Creek and along minor tributaries on the south side as far east as Bartley. It is also exposed along the valley sides of Beaver Creek and its tributaries in the southeastern part of Red Willow County. The lime-cemented beds are locally called "magnesia rock" and the dense silica-cemented beds are sometimes erroneously called "granite." Certain unconsolidated zones of the Ogallala are relatively permeable and yield water to wells where such deposits occur below the level of the water table.

As stated above, the Cretaceous formations were folded and eroded prior to the accumulation of the sediments of the Ogallala formation. The Cretaceous rocks dip gently westward across Red Willow and Frontier counties inasmuch as the area, in general, is situated on the westward sloping flank of the Cambridge arch. The long erosion period that followed the folding of the Cretaceous rocks removed practically all of the Pierre shale in the eastern parts of the two counties and variable amounts of the Niobrara formation from the upfolded areas. All of the Niobrara formation as well as the lowermost parts of the Pierre shale have been preserved in the extreme western part of the area.

The Pierre shale present in Red Willow and Frontier counties is a dark gray to black shale. Its occurrence, both surface and subsurface, is limited to a relatively small area in the western part of each county, where only the lowermost part of the formation has been preserved. The Pierre shale crops out on the north side of the

^{1/} Condra, G. E., Geology and water resources of Republican Valley, Nebraska, U. S. Geol. Survey Water-Supply Paper 216, 1907

Condra, G. E. and Reed, E. C., The geological section of Nebraska, Nebr. Geol. Survey Bull. 14, November, 1943

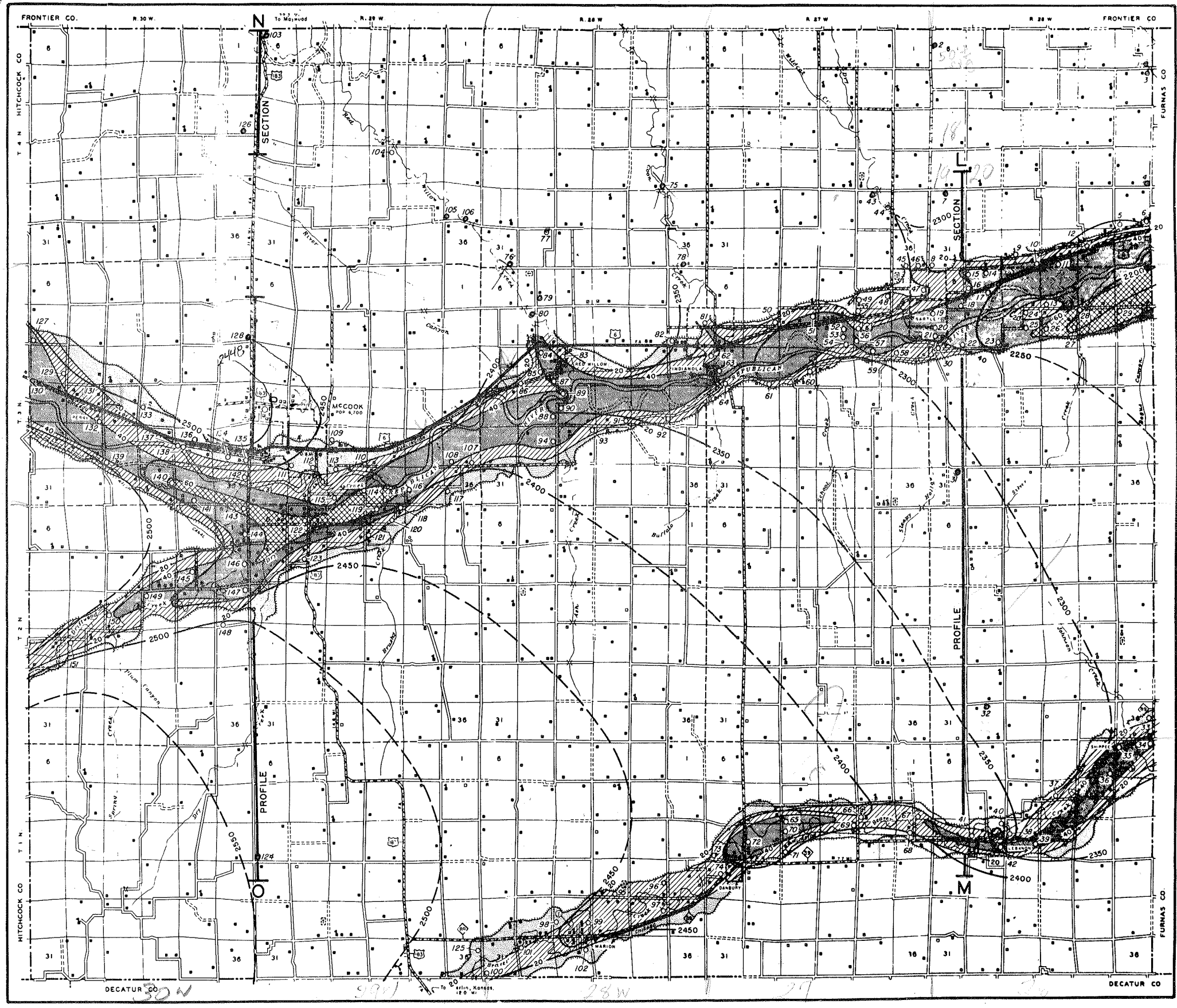
Republican River about 1 mile west of McCook and on the south side of the Republican River at a point about 1 mile east of the Hitchcock-Red Willow County line and extends eastward about one mile. So far as known, the Pierre shale is not exposed in Frontier County. The Pierre shale is practically impervious and yields water to wells only where it is jointed or fractured. No wells are known to derive their water supply from the Pierre shale in these two counties.

The Niobrara formation consists predominantly of chalky shale in its upper and middle parts and chalky limestone in its lower part. It is about 450 feet in thickness where all of the formation has been preserved from erosion as in the central and western parts of Red Willow County, but increasing amounts of the upper part have been removed in an eastward direction. So far as known, the Niobrara formation is not exposed in Red Willow County. The upper part of the Niobrara formation is exposed on both sides of Medicine Creek Valley along that part of its course from a point about 6 miles north of the Frontier-Red Willow-Furnas County line southeastward to that county line. In this stretch, the upper part and a portion of the middle part of the formation are exposed in the southeast quarters of sections 14 and 15 respectively, in T. 5 N., R. 26 W. in Frontier County. The Niobrara formation is relatively impermeable and does not yield water to wells except where it is jointed or fractured.

The Carlile shale underlies the Niobrara formation. It is not exposed in either Red Willow or Frontier counties, but it is present at depth. The top of the Carlile increases in depth from about 200 feet in the eastern part of Red Willow County to about 600 feet in the central part of the County and to about 1,100 feet in the western and northwestern part. It consists predominantly of a dark gray to black shale with some chalky layers in its lower part and locally with a thin sandstone (Codell sandstone member) at its top. In this area, the Carlile has an aggregate thickness of about 230 feet. The upper sandstone zone is a potential water-bearing formation in a part of the area, but it is not very reliable as it is absent in many places and generally too deep for ordinary farm wells. Some of the oil tests in Harlan County found water in this sandstone under artesian pressure at depths of 600 to 800 feet. Nothing definite is known about the quality of this water but it is probably mineralized to some extent, especially where it occurs at depths of 300 feet or more as it does in almost all parts of Red Willow and Frontier counties. Better quality water is sometimes obtained at this horizon farther to the east where the sandstone occurs at shallower depth, but wells are generally weak.

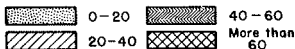
The older Cretaceous rocks, which are not exposed in this area but do occur at depth, are the Greenhorn limestone (about 30 feet thick), the Graneros shale (varying from 40 to 90 feet thick), the Dakota sandstone (about 250 feet thick), the Fuson shale (about 60 feet thick), and the Lakota sandstone (200 to 250 feet thick). Of these formations, the Dakota and Lakota sandstones are the only ones that can be relied upon to furnish satisfactory quantities of ground water. The Dakota sandstone occurs at depths varying from about 550 feet in the eastern part of Red Willow County to about 950 feet in the central part and increasing in depth to about 1400 feet in the western part. The Lakota sandstone is about 300 to 400 feet deeper throughout the area covered by this report. The water from the Dakota and Lakota is here rather highly mineralized and is often quite salty. The mineral concentration in the waters of the Dakota and Lakota is 10 to 15 times greater than in the average shallow mantle rock water.


In general, there are better possibilities of developing adequate supplies of ground water of good quality from sands and gravels in the Pleistocene deposits in Red Willow and Frontier counties than in the underlying bedrock formation.



GROUND-WATER MAP REPUBLICAN VALLEY REGION AND VICINITY REDWILLOW COUNTY, NEBRASKA LEGEND

Approximate thickness of saturated water-bearing sand and gravel in the valley of the Republican River and the valleys of its chief tributaries, in feet:

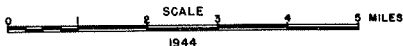


 Cooperative Ground-water Survey test holes

—1700— Contour showing the top of the relatively impervious Cretaceous bedrock; elevations referred to mean sea level and based largely on instrumental levels and partly on topographic maps (contours dashed in areas of poor control)

Prepared by: CONSERVATION AND SURVEY DIVISION, UNIVERSITY OF NEBRASKA
BUREAU OF IRRIGATION, WATER POWER, AND DRAINAGE;
NEBRASKA DEPARTMENT OF ROADS AND IRRIGATION
GEOLOGICAL SURVEY, UNITED STATES DEPARTMENT OF INTERIOR

Base map after General Highway and Transportation map, Nebraska Department of Roads and Irrigation



GROUND-WATER CONDITIONS IN RED WILLOW COUNTY

The test-drilling program in Red Willow County was conducted principally in the Republican Valley and its larger tributary valleys including Beaver Creek, Red Willow Creek and Driftwood Creek respectively. The County may be divided into three generalized ground-water regions: (1) the area north of the Republican Valley, (2) the bottomland and terrace region along the Republican Valley and (3) the region south of the Republican Valley, which may be subdivided into three upland areas separated from each other by bottomland regions along the valleys of Beaver Creek and Driftwood Creek.

The area north of the Republican Valley in Red Willow County (see Ground-Water Map of Red Willow County) is characterized by the presence of relatively thick deposits of sand and gravel which underlie the upland and rest on the Ogallala formation immediately north of the Republican Valley, but these deposits thin northward and may be entirely absent in the extreme northern part of the county (Geologic Profile Section L-M and N-O). The upland surface north of the Republican Valley has been dissected by several tributary streams, the most important one being Red Willow Creek. Several test holes were drilled along Red Willow Creek in order to obtain information concerning the character and thickness of the water-bearing formations in that tributary valley. Ground-water conditions in the vicinity of this stream have been shown in profile section N-O, the northern part of which is based on test holes 103 and 126 that were drilled in the extreme northern part of the county. Because of insufficient control, no attempt was made to show the configuration of the underlying bedrock surface in the area north of the Republican Valley by means of contours.

In Red Willow County the sand and gravel deposits both north and south of the Republican Valley are capped by a relatively thick mantle of loess, except where streams tributary to the Republican River have cut through the loess cap. Recharge of the underlying ground-water reservoir from local precipitation is therefore limited. Because of this fact and because the deposits of sand and gravel are relatively thin, the intensive development of large ground-water supplies in the areas north and south of the Republican Valley will necessarily be restricted.

The Republican Valley has an average width of about 2 miles throughout its course across the county. Locally, as in the vicinity of McCook and Red Willow, it is about 3 miles in width. The tributary valleys of Beaver, Driftwood, and Red Willow creeks average about a mile in width throughout their respective courses in the county.

The Republican Valley in Red Willow County is characterized by a buried channel with relatively low bedrock and comparatively thick overlying deposits of water-bearing sand and gravel. From the vicinity of McCook westward to the county line, the deepest part of the fill in the Republican Valley is located near the southern limit of the Valley. The approximate thicknesses of saturated water-bearing sand and gravel are shown on the Ground Water Map of Red Willow County by means of shaded patterns. The map shows that the maximum thickness of saturated water-bearing material occurs in a narrow belt on the south side of the Republican River in the vicinity of McCook and near the southern limit of the valley from a point about 2 miles east of Bartley to the east county line. The approximate thickness of saturated water-bearing sand and gravel in the valleys of Beaver Creek and Driftwood Creek has also been shown by means of shaded patterns. In general, the saturated water-bearing material in these tributary valleys is not as extensive or as thick as the saturated deposits in the Republican Valley. The shaded patterns shown on the Ground-Water Map of Red Willow County indicate that the maximum thickness of saturated water-bearing material in Beaver Creek Valley occurs in a belt extending from west of Lebanon to Shippee and in a smaller belt near Danbury, whereas the maximum thickness of saturated deposits in the valley of Driftwood Creek occur in a belt extending from its mouth to a point about 6 miles above its junction with the Republican River.

The water table in the Republican Valley region and in the valleys of Red Willow, Beaver, and Driftwood creeks is at a relatively shallow depth (See Geologic Profile Sections L-M and N-O). In these valley areas the conditions are ideal for the infiltration of precipitation that falls in the region, because the clay bed overlying the more permeable sands and gravels is, in most places, comparatively thin or absent. Conditions are likewise favorable in the Republican Valley region for direct recharge to the ground-water reservoir from stream flow. There is a possibility that during periods of heavy stream flow in Beaver, Red Willow, and Driftwood creeks, and perhaps in other smaller tributaries, some recharge takes place to the underlying zone of saturation. The ground water in the Republican Valley region receives some contribution from upland areas north of it in the form of water moving in toward the Valley (see Geologic Profile sections L-M and N-O).

The yields of wells installed in the alluvium of the Republican Valley region range from several gallons to more than 1,000 gallons a minute. It is reported that one of the municipal wells at McCook, drilled on the south side

of the Republican River, was 84 feet deep and yielded 900 gallons a minute with a draw-down of only 7 feet. The depth to water level in this well was about 20 feet. It is also reported that irrigation wells situated in the same productive belt of the alluvium on the south side of the river near McCook have yielded more than 1,000 gallons a minute.

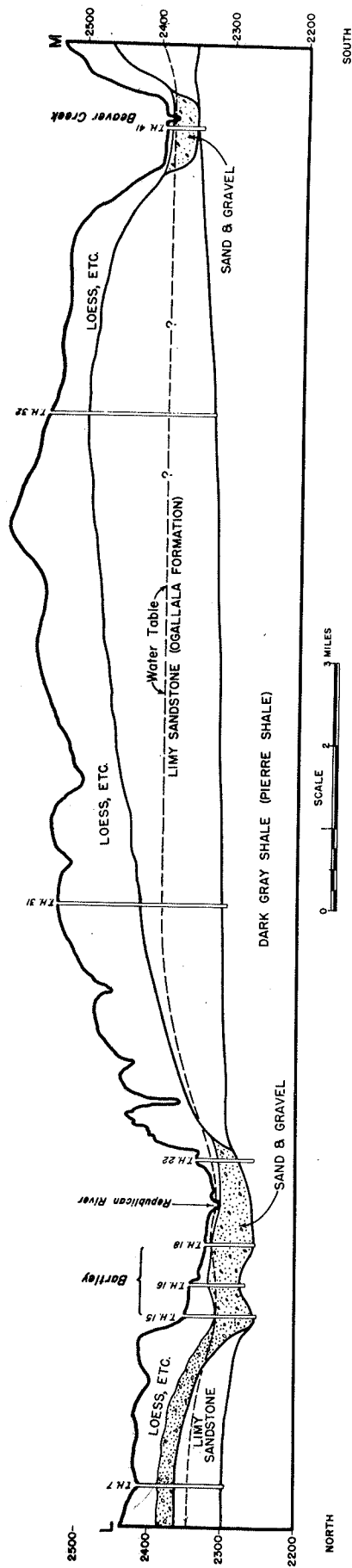
The yields of wells installed on the uplands both north and south of the Republican Valley are considerably less. Many of the wells tap the saturated part of the Ogallala formation that underlies much of the upland areas. One well, installed in the northwestern part of the county, was completed to a depth of 334 feet, the bottom of the water-bearing sands being at 329 feet and the static water level at a depth of 240 feet. This well is situated in the general vicinity of test hole 126 shown on Profile section N-O, and derives its water supply from the Ogallala formation. It is reported that the well yielded 125 gallons a minute with a draw-down of 57 feet. It is believed that, in general, the yields of ordinary domestic and livestock wells in the upland areas are somewhat less than this amount.

The upland region south of the Republican Valley may be subdivided into 3 parts separated from each other by the valleys of Beaver and Driftwood creeks. The three areas are similar hydrologically and, in general, are characterized by shale bedrock (Pierre shale) which is overlain by limy sandstone and lime-cemented silts of the Ogallala formation capped by loess (Geologic Profile Sections L-M and N-O). They differ from the upland areas north of the Republican Valley in at least one respect, namely, the relative absence of sand and gravel

overlying the Ogallala formation. If present, these deposits of sand and gravel are poorly developed and are not very dependable as a source of water supply. Because of the more or less impermeable nature of the loess cover that mantles most of the region south of the Republican Valley, the possibilities of infiltration of precipitation falling over the region are very limited. In the divide areas between the Republican Valley and the valleys of Beaver and Driftwood creeks, the more permeable materials overlying the shale bedrock are subject to natural leakage along the valley sides of the Republican as well as along the valley sides of the tributary streams of Beaver and Driftwood creeks. In a few local areas where the shale bedrock and the limy sandstones and silts of the Ogallala formation are overlain by thin deposits of unconsolidated sand and gravel, there are possibilities of developing small water supplies where the water table is up in the more permeable materials.

The bottom land regions along Beaver and Driftwood creeks are similar hydrologically to those in the Republican Valley region, but are on a much smaller scale. There are reasonably good possibilities of developing small water supplies in places along these valleys where there is sufficient thickness of underlying saturated water-bearing material.

In general, the conditions in the 3 principal ground-water regions in Red Willow County are shown in the following Geologic Profile Sections:



Section L-M. This section is located about one-half mile east of Bartley and extends in a north-south direction from a point 3.5 miles south of the Frontier County line (L) to a point 2.5 miles north of the Nebraska-Kansas state line (M). Note the presence of the sand and gravel deposit overlying the Ogallala formation north of the Republican Valley and the absence of similar deposits south of the Valley; the areas of favorable infiltration in the vicinities of the Republican Valley and Beaver Creek Valley; the gradually rising shale bedrock (Pierre shale) south of the Republican Valley between the Republican River and the State line, overlain by limy sandstone and silt of the Ogallala formation (Tertiary age); and the relatively thick mantle of loess capping the upland areas and intermediate slopes both north and south of the Republican Valley. The dashed line representing the water table indicates that the water table slopes southward to the Republican Valley, in the region north of the Valley. The position of the water table between the Republican Valley and Beaver Creek Valley is inferred in the divide areas where control is limited. The dark gray shale is part of the Pierre shale of Upper Cretaceous age. The Pierre shale is relatively impervious and does not provide a source of water for this area.

LOGS OF TEST HOLES DRILLED IN RED WILLOW COUNTY
BY THE CONSERVATION AND SURVEY DIVISION,
THE BUREAU OF IRRIGATION AND THE FEDERAL GEOLOGICAL SURVEY

12,000
50
60,000+

1. SE $\frac{1}{4}$ Sec. 1, T.4 N., R.26 W.; 0.15 mile west of southeast corner, 120 feet east of road to north. Ground elevation, 2,294 feet (a); depth to water, 10.2 feet, July 28, 1941.

ROAD FILL and fine brown sand - - -	14	14
GRAVEL, fine to medium, reddish - -	(5)	19
GRAVEL, fine to coarse, red - - -	(3)	22
SILT, brownish gray; organic matter	7	29
SILT, brownish gray; some gravel,		
wood - - - - -	8	37
SILT, brownish gray - - - - -	2	39
WOODY MATERIAL - - - - -	1	40
SILT, bluish gray - - - - -	10	50
GRAVEL, medium, gray; poor - - - -	(2)	52
SHALE, gray, slight greenish lime -	3	55

2. NW $\frac{1}{4}$ Sec. 6, T.4 N., R.26 W.; 0.1 mile north of southwest corner of quarter, on east edge of road. Ground elevation, 2,522 feet (a); depth to water, 148.7 feet, September 15, 1941.

SILT, light buff; gastropod shells, dark soil at top (Peorian) - - -	34	34
SILT, clayey, reddish buff, darker near top (Loveland) - - - - -	8	42
SILT, clayey, limy, whitish buff (Loveland) - - - - -	2	44
SILT, light buff - - - - -	5	49
SILT, limy, white; less limy and more buff farther down (Loveland)	6	55
SILT, light buff (Loveland) - - - -	1	56
SILT, clayey, limy, whitish buff (Loveland) - - - - -	1	57
SILT, light buff (Loveland) - - - -	12	69
SILT, clayey, limy, light buff (Loveland) - - - - -	4	73
SILT, clayey, buff (Loveland) - - -	5	78
SILT, clayey, reddish (Loveland) -	10	88
SILT, limy, pale; lime nodule (Loveland) - - - - -	1	89
SILT, clayey, light buff (Loveland)	4	93
SANDSTONE, hard, silty, limy, pinkish to flesh-colored (Ogallala) -	8	101
SANDSTONE, less limy, softer, browner, some pebbles (Ogallala) - - - -	5	106
SANDSTONE, silty, limy, light pinkish brown; scattered pebbles, harder zone	14	120
SANDSTONE, less limy, softer - - -	3	123
FLINT, limy, dense, light flesh-colored; hard limy sandstone - - - - -	4	127
SANDSTONE, fine, silty, very limy, light yellow; not very hard - - -	1	128
MUDSTONE, fine, dense, limy, pale, flesh-colored; very hard - - - -	2	130
SILT, soft, sandy, limy, grayish buff	1	131
SILTSTONE, sandy, limy, hard, light tan - - - - -	8	139

SILT, soft, sandy, light greenish	1	140
SILT, sandy, limy, hard, light yellowish green - - - - -	4	144
SAND, soft, fine, silty, tan - - -	4	148
SILTSTONE, limy, light brownish gray	4	152
GRAVEL, fine, pink; predominantly green grains - - - - -	16	168
SILT, limy, pale greenish; not very hard - - - - -	2	170
GRAVEL, fine, pinkish and green - -	1	171
GRAVEL, fine to medium, green pinkish - - - - -	7	178
SANDSTONE, silty, light gray, slightly greenish; sandy siltstone	10	188
SILT, lime white, pale greenish - -	1	189
GRAVEL, fine to medium, green, some pinkish; angular pebbles - - - -	1	190
SILT, clayey, pale greenish, lime white - - - - -	3	193
GRAVEL, medium to fine, green, pink; angular pebbles - - - - -	5	198
SILT, cemented, lime white - - - -	1	199
GRAVEL, medium, pink and green, angular pebbles - - - - -	11	210
SILT, clayey, lime white - - - - -	2	212
GRAVEL, fine to medium, white and pinkish, angular fragments - - -	9	221
GRAVEL, greener - - - - -	1	222
QUARTZITE, very hard, green and flesh-colored - - - - -	2	224
CLAY and chert, buff (Niobrara) - -	1	225

3. NE $\frac{1}{4}$ Sec. 12, T.4 N., R.26 W.; 320 feet west of Northeast corner of section, 320 feet west of bridge, on south edge of road. Ground elevation, 2,290 feet (a); depth to water, 9.4 feet, July 28, 1941.

ROAD FILL, mostly sand - - - - -	2	2
CLAY, sandy, dark buff - - - - -	12	14
SAND and woody material - - - - -	5	19
GRAVEL, medium, bluish green - - -	3	22
CLAY, light buff - - - - -	1	23
GRAVEL, medium to coarse, bluish green; much water-worn shale, siltstone and limestone - - - - -	36	59
SHALE, bluish gray - - - - -	6	65

4. SE $\frac{1}{4}$ Sec. 24, T.4 N., R.26 W.; 65 feet north of southeast corner, on west edge of road. Ground elevation, 2,395 feet (a); depth to water, caved at 98.3 feet, September 15, 1941.

SILT, buff - - - - -	38	38
SILT, clayey, sandy, reddish buff -	30	68
SAND and silt, very fine, light gray	16	84
SAND, silty, light greenish gray -	3	87
GRAVEL, fine to medium, white, yellow, green, red - - - - -	6	93

(t) Elevations estimated from topographic map.
(a) Elevations obtained by altimeter levels.

(i) Elevations established by instrumental levels.

36
13
108
36
468

RED WILLOW COUNTY

16
12
3

Sub
78.3

	Thick- ness (feet)	Depth (feet)
SILT, whitish to greenish gray; some sand - - - - -	14	107
CLAY, hard, green; chips - - - - -	1	108
GRAVEL, fine to medium, green, red, yellow, white; large lime pebbles - - - - -	4	112
CLAY, silty, brownish tan - - - - -	4	116
SILT, clayey, brownish tan - - - - -	7	123
CLAY, silty, whitish tan; some grit and gravel - - - - -	3	126
GRAVEL, fine to medium, green, red, white; mostly fine, some lime pebbles - - - - -	12	138
SHALE, ochre colored - - - - -	5	143
SHALE, dark olive brown - - - - -	15	158
SHALE, very dark gray to almost black; dark blue color when wet - - - - -	2	160

5. Center of NW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 36, T.4 N., R.26 W.; 90 feet east of intersection of old highway and road to north, on north edge of road. Ground elevation, 2,297 feet (t); depth to water, 22.2 feet, July 28, 1941.

ROAD FILL and sandy clay - - - - -	9	9
GRAVEL, medium, compact, red; much sand - - - - -	23	32
GRAVEL, medium to coarse, red; good - - - - -	8	40
GRAVEL, medium, very compact, red; much clay - - - - -	22	62
SHALE, creamy tan at first to greenish gray at 69 feet - - - - -	7	69

6. SE $\frac{1}{4}$ Sec. 25, T.4 N., R.26 W.; 120 feet west of southeast corner, on north edge of road. Ground elevation, 2,279 feet (t); depth to water, 12.4 feet, July 28, 1941.

ROAD FILL and brown sandy clay - - - - -	8	8
GRAVEL, fine to medium, red; compact, clean - - - - -	14	22
GRAVEL, medium to coarse, red; some sand, clean and not as compact as above, clay seam at 22 feet - - - - -	7	29
SHALE, light tan, greenish cast, some white - - - - -	7	36

7. NE $\frac{1}{4}$ Sec. 30, T.4 N., R.26 W.; 135 feet east of northwest corner of quarter on south edge of road. Ground elevation, 2,434 feet (a); depth to water, 90.5 feet, September 15, 1941.

SILT, light buff (Peorian) - - - - -	35	35
SILT, clayey, reddish brown, lighter colored near bottom (Loveland) - - - - -	12	47
SILT, clayey, grayish buff (Loveland) - - - - -	3	50
GRAVEL, medium, pinkish; poorly sorted - - - - -	11	61
SILT, light tan - - - - -	1	62
GRAVEL, fine to medium, pinkish and greenish; pebbles not well rounded, probably not well sorted, contains limy pebbles (Loveland) - - - - -	10	72
SILT, sandy, clayey, grayish green; zones of hard greenish white lime (Ogallala) - - - - -	8	80

SAND, fine, hard, green; contains dense hard concretions - - - - -	9	89
SANDSTONE, soft, brownish green; fine gravel - - - - -	11	120
SAND, fine, grayish green; similar to that above, but softer - - - - -	520	106
CLAY, silty, light green; much limy white clay, probably in the form of concretions - - - - -	6	112
CLAY, silty, green, similar to that above, but having no limy white clay at top; becomes more abundant downward - - - - -	16	128
GRAVEL, sandy, pink and green; poorly sorted, may also contain clay - - - - -	9	137
SHALE, whitish buff; more buff to tan with depth - - - - -	3	140

8. Southwest corner of Sec. 31, T.4 N., R.26 W.; 75 feet north of corner, on east edge of road. Ground elevation, 2,360 feet (t); depth to water, 40.2 feet, August 4, 1941.

ROAD FILL and clay, black - - - - -	9	9
CLAY, somewhat sandy, hard, buff or khaki colored - - - - -	31	40
SILT, robin egg blue color - - - - -	15	55
CLAY, buff; some gravel - - - - -	3	58
GRAVEL, medium, red; good, clean - - - - -	18	76
SHALE, water-worn, cream colored to lemon yellow - - - - -	1	77
SHALE, soft, ochre, cream colored to yellow - - - - -	2	79

9. Southeast corner of SW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 33, T.4 N., R.26 W.; 105 feet southwest of bridge, on northwest edge of road. Ground elevation, 2,330 feet (t); depth to water, caved at 28.5 feet, July 28, 1941.

ROAD FILL - - - - -	5	5
CLAY, sandy, dark buff - - - - -	12	17
GRAVEL, medium, compact, red; much buff clay - - - - -	13	30
GRAVEL, medium, red; some black clayey material - - - - -	5	35
GRAVEL, medium to coarse, compact, red; some buff clay - - - - -	6	41
SHALE, tan, some lighter color - - - - -	4	45

10. Southeast corner of SE $\frac{1}{4}$ Sec. 33, T.4 N., R.26 W.; 80 feet west of east section line, in ditch on north side of highway. Ground elevation, 2,303 feet (t); depth to water, 12.1 feet, July 28, 1941.

ROAD WASH, sandy loam, black - - - - -	5	5
CLAY, sandy, tan - - - - -	6	11
GRAVEL, fine to medium, sandy, red - - - - -	9	20
GRAVEL, medium to coarse, red; good, loose, clean, clay seam at 35 feet, reddish yellow clay - - - - -	35	55
SHALE, yellowish tan or brown - - - - -	4	59

RED WILLOW COUNTY

	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
11. Southeast corner of SW $\frac{1}{4}$ Sec. 34, T.4 N., R.26 W.; 0.3 mile south of highway. Ground elevation, 2,296 feet (t); depth to water, 10.7 feet, July 28, 1941.			GRAVEL, fine, red; compact, much clay - - - - -	8	50
CLAY, sandy, buff to dark gray - -	10	10	GRAVEL, fine, red; compact, much yellow clay - - - - -	25	75
GRAVEL, medium to coarse, green; good	15	25	SHALE, light tan, some whitish color	4	79
GRAVEL, medium to coarse, red; good, loose - - - - -	5	30	15. NW $\frac{1}{4}$ Sec. 5, T.3 N., R.26 W.; 175 feet south of northwest corner of section, on east edge of road. Ground elevation, 2,350 feet (t); depth to water, 42.3 feet, July 28, 1941.		
GRAVEL, fine to coarse, red; some-what compact, clean - - - - -	26	56	ROAD FILL - - - - -	5	5
SHALE, soft, sticky, yellow ochre -	3	59	CLAY, brown - - - - -	30	35
12. Northeast corner of NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 35, T.4 N., R.26 W.; 620 feet east of section line, 330 feet east of bridge, on south edge of road. Ground elevation, 2,307 feet (t); depth to water, 23.5 feet, July 28, 1941.			CLAY, sandy, tan; some gravel - - -	5	40
ROAD FILL - - - - -	2	2	GRAVEL, fine to medium, red; compact, much clay - - - - -	25	65
CLAY, dark buff - - - - -	18	20	GRAVEL, medium, red; compact, some yellow clay - - - - -	30	95
GRAVEL, fine to medium, red; compact, much sand - - - - -	26	46	GRAVEL, medium to coarse, red; some clay, not as compact as above - -	3	98
GRAVEL, hard, red; much buff clay -	4	50	SHALE, whitish to tan - - - - -	1	99
GRAVEL, medium to coarse, red; loose, some sand - - - - -	13	63	16. Southwest corner of NW $\frac{1}{4}$ Sec. 5, T.3 N., R.26 W.; 0.2 mile north of highway, on east edge of road. Ground elevation, 2,335 feet (t); depth to water, 29.2 feet, July 28, 1941.		
SHALE, creamy buff to darker - - -	6	69	ROAD FILL, dark brown - - - - -	5	5
13. SW $\frac{1}{4}$ Sec. 3, T.3 N., R.26 W.; 0.25 mile east of southwest corner of section, on north edge of road. Ground elevation, 2,294 feet (t); depth to water, 7.3 feet, September 1, 1941.			CLAY, sandy, buff to darker - - - -	20	25
ROAD FILL and dark brownish black clayey sand - - - - -	6	6	GRAVEL, medium to coarse, red; some clay - - - - -	15	40
GRAVEL, fine to coarse, red; good -	6	12	GRAVEL, fine to medium, red; some yellow clay, somewhat tight - - -	27	67
GRAVEL, fine to coarse, red, some green; very good, loose - - - - -	8	20	SHALE, greenish gray to yellowish -	8	75
GRAVEL, fine to coarse, red; loose, good, mostly coarse - - - - -	6	26	17. SW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 5, T.3 N., R.26 W.; 300 feet north of southeast corner, 85 feet south of railroad, on west side of the $\frac{1}{4}$ mile roadway. Ground elevation, 2,306 feet (t); depth to water, 3 feet, August 4, 1941.		
GRAVEL, fine to coarse, compact, red	9	35	LOAM, sandy, black - - - - -	3	3
GRAVEL, fine to medium, some coarse, compact - - - - -	6	41	SAND, red - - - - -	17	20
GRAVEL, coarse, loose, red - - - -	3	44	GRAVEL, fine to medium, red; good, clean, some lime - - - - -	25	45
CLAY, very tough, sticky, gray - -	6	50	GRAVEL, medium to coarse, red; more compact than above, some limy concretions - - - - -	11	56
CLAY, sticky, softer than above, gray - - - - -	19	69	SHALE, soft, cream colored to yellow tan - - - - -	3	59
14. NE $\frac{1}{4}$ Sec. 5, T.3 N., R.26 W.; 0.34 mile west of northeast corner of section, 130 feet west of drainage, on south edge of road. Ground elevation, 2,335 feet (t); depth to water, 34.2 feet, July 28, 1941.			18. Southeast corner of Sec. 6, T.3 N., R.26 W.; northwest corner of intersection. Ground elevation, 2,328 feet (t); depth to water, 9.6 feet, July 28, 1941.		
ROAD FILL, brown sandy clay - - - -	5	5	CLAY, buff - - - - -	9	9
CLAY, sandy, light brown - - - - -	15	20	GRAVEL, medium to coarse, red; good	10	19
CLAY, dark brown - - - - -	5	25	GRAVEL, coarse, green; good - - - -	11	30
GRAVEL, fine to medium, sandy, compact, red - - - - -	5	30	GRAVEL, medium to coarse, red and green; good - - - - -	15	45
GRAVEL, medium, red, and sandy light tan clay - - - - -	5	35	GRAVEL, coarse, red; good, loose -	20	65
GRAVEL, fine to medium, red; some clay - - - - -	7	42	SHALE, yellow, ochre to tan - - - -	1	66

19. NW $\frac{1}{4}$ Sec. 7, T.3 N., R.26 W.; 0.15 mile east and 225 feet south of northwest corner of quarter, on west side of road. Ground elevation, 2,326 feet (t); depth to water, 10.9 feet, September 8, 1941.

	Thick- ness (feet)	Depth (feet)
ROAD FILL, black loam - - - - -	5	5
CLAY, slightly sandy, brownish black	1	6
CLAY, quite sandy, brownish gray -	1	7
GRAVEL, medium to coarse, brown - -	3	10
GRAVEL, fine, brown; some organic material - - - - -	6	16
GRAVEL, medium to coarse, reddish brown - - - - -	13	29
GRAVEL, coarse, brown - - - - -	9	38
GRAVEL, fine to medium, brownish red	16	54
SHALE, yellowish buff - - - - -	3	57
SHALE, olive drab - - - - -	2	59

20. SW $\frac{1}{4}$ Sec. 7, T.3 N., R.26 W.; 0.15 mile east and 140 feet south of northwest corner, on east edge of road. Ground elevation, 2,322 feet (t); depth to water, 7.7 feet, September 8, 1941.

ROAD FILL and fine sand, compact -	4	4
SAND and fine to coarse gravel, red; clean - - - - -	6	10
SILT, gray, and fine gravel - - - -	3	13
SILT, gray; some gray gravel, dirty, compact - - - - -	7	20
SAND, fine, gray - - - - -	10	30
GRAVEL, fine, grayish red - - - - -	2	32
GRAVEL, fine to coarse, red; clean, loose - - - - -	14	46
GRAVEL, fine to coarse, red; compact	9	55
GRAVEL, coarse, red; good - - - - -	5	60
SHALE, compact, olive brown - - - -	5	65

21. SW $\frac{1}{4}$ Sec. 7, T.3 N., R.26 W.; 0.15 mile east and 0.23 mile south of northwest corner of quarter, 0.2 mile north of south edge of river bridge, on east edge of road. Ground elevation, 2,322 feet (t); depth to water, caved at 8 feet, September 8, 1941.

ROAD FILL - - - - -	5	5
GRAVEL, fine to coarse, mostly fine to medium, red; good - - - - -	25	30
GRAVEL, fine to medium, good - - - -	5	35
GRAVEL, fine to coarse, red; good -	6	41
SAND and fine to medium gravel, red	4	45
GRAVEL, fine to coarse, red; good -	6	51
CLAY, sandy, reworked shale and gravel - - - - -	4	55
SHALE, reworked, cream colored; seams to have a little gravel, may be because shale is soft - - - - -	3	58
SHALE, cream colored - - - - -	3	61
SHALE, dark olive brown; tough compact - - - - -	7	68

22. Southeast corner of Sec. 7, T.3 N., R.26 W.; 8 feet north of road, 45 feet east of bridge over drainage, 120 feet west of section line. Ground elevation, 2,330 feet (t); depth to water, 18.5 feet, September 8, 1941.

SOIL, sandy, dark brown, and buff sand - - - - -	7	7
SAND, clayey, buff - - - - -	6	13
SILT, grayish buff - - - - -	3	16
SILT, gray, and fine gray gravel -	2	18
GRAVEL, fine to medium, reddish gray - - - - -	3	21
GRAVEL, fine to coarse, red - - - -	8	29
GRAVEL, fine to medium, some coarse; some water-worn sandy clay - - - -	31	60
GRAVEL as above; more water-worn clay and shale - - - - -	8	68
SAND, clayey, soft, tan; may have some gravel - - - - -	7	75
SHALE, soft, yellow - - - - -	2	77
SHALE, sticky, light grayish tan -	2	79

23. SE $\frac{1}{4}$ Sec. 8, T.3 N., R.26 W.; 0.15 mile north of southeast corner of section, on west edge of road. Ground elevation, 2,322 feet (t); depth to water, 20.1 feet, September 1, 1941.

ROAD FILL and dark brown sandy soil	5	5
SAND, brownish buff - - - - -	5	10
CLAY, sandy, dark brown - - - - -	2	12
SAND, clayey, buff gray; compact -	5	17
GRAVEL, fine to medium - - - - -	3	20
SAND, reddish; poor sample (losing water) - - - - -	9	29
GRAVEL, fine to coarse, reddish - -	6	35
CLAY, sandy, light grayish tan - -	8	43
GRAVEL, fine to medium, greenish red; compact - - - - -	17	60
CLAY, sticky, compact, khaki colored; thin limy layer at 62 feet - - - -	10	70
CLAY, sandy, brown, khaki colored; some red embedded sand - - - - -	5	75
SHALE, cream colored to whitish gray to tan; compact, sticky - - - - -	9	84
SHALE, dark olive gray; compact, tough - - - - -	2	86

24. NE $\frac{1}{4}$ Sec. 9, T.3 N., R.26 W.; 0.45 mile west of northeast corner of section, near road corner, on south edge of road. Ground elevation, 2,305 feet (t); depth to water, 10.5 feet, September 1, 1941.

SAND and dark brown sandy soil - -	4	4
SAND, clayey, compact, grayish brown	4	8
GRAVEL, fine to coarse, red; clean	7	15
GRAVEL, fine to medium, some coarse, red; some gray silt seams - - - -	10	25
GRAVEL, fine to medium, some coarse, red - - - - -	6	31
GRAVEL, fine to coarse, red; good -	13	44
CLAY, greenish gray first few inches then light khaki colored - - - -	11	55
CLAY, sandy, hard, dark khaki to reddish brown; cuts into chips -	2	57
CLAY, sticky, light khaki - - - - -	6	63
CLAY, sandy, reddish brown; compact, cuts chips like sandstone - - - -	5	68
CLAY, sticky, yellow brown - - - -	3	71
SHALE, lime, sticky, whitish gray -	7	78
SHALE, whitish gray to cream colored; compact, very sticky - - - - -	7	85
SHALE, light gray to dark olive brown to almost black; hard, compact -	4	89

	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
25. NE $\frac{1}{4}$ Sec. 9, T.3 N., R.26 W.; 300 feet north of southwest corner of quarter, just north of curve, on east edge of road. Ground elevation, 2,310 feet (t); depth to water, 13.2 feet, September 1, 1941.			CLAY, sandy, hard, light tan or khaki colored; some gravel, fairly good seam of gravel at 60 feet and at 90 feet - - - - -	52	105
			GRAVEL, very coarse, red; some pieces of limy material - - - - -	14	119
SOIL, sandy, dark brown - - - - -	7	7			
GRAVEL, fine to coarse, clean, red	13	20	28. Northwest corner of Sec. 11, T.3 N., R.26 W.; 60 feet south of corner, on east edge of road. Ground elevation, 2,294 feet (t); depth to water, 9.5 feet, September 1, 1941.		
GRAVEL, fine to coarse, red; some silty clay - - - - -	5	25			
GRAVEL, fine to coarse, red; some water-worn shale - - - - -	8	33	ROAD FILL, dark brown sandy clay and buff clayey sand - - - - -	10	10
CLAY, compact, light khaki colored	10	43	SAND and fine gravel, red - - - - -	4	14
CLAY, sandy, hard like sandstone; thin layers of limestone at 43 and 45 feet - - - - -	2	45	SAND and fine to medium gravel, red	11	25
CLAY, compact, light khaki colored, light brownish yellow - - - - -	16	61	GRAVEL, fine to coarse, compact, red - - - - -	3	28
CLAY, sandy, hard, brown, khaki colored; cuts into chips like soft sandstone - - - - -	9	70	GRAVEL; some water-worn shale and brown sandy clay, compact, red -	4	32
CLAY or shale, sticky, tan - - - - -	4	74	GRAVEL, fine to medium, compact, red	13	45
SHALE, sticky, very limy, whitish gray to tan - - - - -	5	79	GRAVEL, slightly coarser than above, compact, red - - - - -	4	49
			CLAY, sticky, light khaki colored -	9	58
			ROCK - - - - -	1	59
26. NW $\frac{1}{4}$ Sec. 10, T.3 N., R.26 W.; 0.1 mile east of southwest corner of quarter, 8 feet north of fence. Ground elevation, 2,318 feet (t); depth to water, 26.4 feet, October 7, 1941.			CLAY, sandy, dark khaki; some embedded gravel - - - - -	10	69
SOIL - - - - -	5	5	GRAVEL, fine, compact, reddish; some sandy clay - - - - -	4	73
SILT, dark brown; soil and dirty gravel - - - - -	3	8	CLAY, sandy, khaki colored - - - - -	2	75
GRAVEL, fine, reddish; dirty - - - - -	3	11	GRAVEL, fine to medium, compact, red; some lime and shale - - - - -	11	86
SILT, buff, and silty clay - - - - -	12	23	SHALE, cream colored to light grayish tan - - - - -	6	92
GRAVEL, fine to coarse, red; good -	18	41	SHALE, tough, dark olive brown - -	3	95
CLAY, compact, gray - - - - -	7	48			
CLAY, soft, tan - - - - -	4	52	29. Northwest corner of Sec. 12, T.3 N., R.26 W.; 40 feet east of corner on south edge of road. Ground elevation, 2,312 feet (t); depth to water, 37.7 feet, August 4, 1941.		
CLAY, tannish brown; hard indurated tan clay seams - - - - -	19	71			
CLAY, sandy, tannish brown, compact; hard sandy lime lenses or concretions - - - - -	8	79	ROAD FILL, clayey, brown - - - - -	4	4
CLAY, compact, tan to brown - - - - -	4	83	CLAY, sandy, light brown - - - - -	16	20
CLAY, compact, tan, hard indurated pinkish tan clay - - - - -	4	87	GRAVEL, fine, red, and fine sand, compact - - - - -	10	30
SANDSTONE, soft, dark brown - - - - -	5	92	GRAVEL, coarse, red; clean, loose, some lime - - - - -	20	50
GRAVEL, fine to medium, some coarse, reddish; some water-worn shale and clay - - - - -	5	97	GRAVEL, medium, red; rather compact, much lime - - - - -	30	80
GRAVEL, fine to coarse, mostly red; has water-worn shale and clay -	4	101	GRAVEL, medium to coarse, red; good	13	93
SHALE, cream colored to pink to slightly grayish tan - - - - -	5	106	GRAVEL, very coarse, red; seam of yellowish tan clay at 99 feet - -	18	111
SHALE, compact, dark olive gray (Niobrara) - - - - -	4	110	SHALE, cream colored at first becoming dark tan or khaki - - - - -	8	119
27. Southeast corner of NE $\frac{1}{4}$ Sec. 10, T.3 N., R.26 W.; on west edge of road. Ground elevation, 2,314 feet (t); depth to water, 28 feet, August 4, 1941.					
ROAD FILL - - - - -	5	5	30. NW $\frac{1}{4}$ Sec. 18, T.3 N., R.26 W.; 1500 feet south and 0.15 mile east of northwest corner of section, 90 feet east of road to north, on north edge of east and west road. Ground elevation, 2,329 feet (t); depth to water, 12.6 feet, September 8, 1941.		
CLAY, sandy, buff - - - - -	19	24			
GRAVEL, medium to coarse, loose, red; clean, some lime - - - - -	29	53	ROAD FILL and dark brown sandy soil	5	5
			SAND, clayey, buff - - - - -	3	8
			SILT, gray - - - - -	4	12
			SAND and fine to coarse gravel, red	8	20
			GRAVEL, fine to coarse, red - - - - -	5	25
			GRAVEL, fine to coarse, less fine than above, red; good - - - - -	5	30

	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
SAND, hard, gray; cemented, cuts in chips, like sandstone - - - - -	4	34	GRAVEL, cemented, similar to that above - - - - -	4	213
SANDSTONE, hard; gray - - - - -	1	35	SILT, sandy, clayey, light grayish whitish green; much lime, compact but not very hard - - - - -	2	215
GRAVEL, fine to medium, some coarse, much fine, red - - - - -	10	45	GRAVEL, medium, many pink and red pebbles, few green - - - - -	3	218
SHALE, sticky, yellowish tan, white	2	47	SHALE, soft, white (Niobrara) - - -	6	224
SHALE, tan to light olive brown - -	4	51	SHALE, light gray to iron gray - -	6	230
SHALE, hard, compact, dark olive brown - - - - -	8	59			

31. Sec. 31, T.3 N., R.26 W.; 0.16 mile west of northeast corner, on south edge of road. Ground elevation, 2,527 feet (a); depth to water, 159.5 feet, September 15, 1941.

SILT, light yellow or buff, loess (Peorian); abundant gastropod shells - - - - -	38	38
SILT, clayey, reddish buff, dark brown at top, paler with depth; loess (Loveland) - - - - -	19	57
SILT, clayey, light tan, lime nodules and soft lime; loess (Loveland) -	10	67
SILT, clayey, browner; less lime -	2	69
SILT, lighter colored; more lime -	6	75
SILT; generally less lime - - - -	13	88
SILT, sandier; concretions and soft lime - - - - -	15	103
SAND, massive, clayey, tan; associated with sandy, clayey silt (Loveland) - - - - -	9	112
SILT, clayey; mixed with sand grains and thin beds of fine gravel (Loveland) - - - - -	4	116
SAND, fine, silty, massive, light gray (Ogallala); or basal Loveland CLAY, indurated, compact, limy, white about two feet then green clayey silt, soft but limy; also contains green hard indurated clay, dense and brittle, almost vitreous - -	8	124
CLAY, indurated, hard, vitreous, dense, white and pale green - - -	6	138
CLAY, soft, light gray to white and light brown; some silt and grains of sand, alternating hard and soft zones - - - - -	20	158
SAND, silty, massive, soft, greenish yellow; coarser and softer than above - - - - -	17	177
SILT, clayey, limy, light gray to white; sand grains - - - - -	1	178
CLAY, limy, vitreous, light or whitish green; chips in sample from 177 to 179 feet - - - - -	1	179
CLAY, light greenish gray; grains of silt or fine sand - - - - -	6	185
CLAY, limier, paler colored; some scattered pebbles of fine gravel	7	192
GRAVEL, medium, pink and green pebbles - - - - -	7	199
SILT, sandy, limy white; fairly soft, compact, much lime, probably some clay - - - - -	5	204
GRAVEL, medium; more red grains than in gravel from 192 to 199 feet	5	209

3 x 1700 3600
21 200

32. Northwest corner of NE 1/4 Sec. 32, T.2 N., R.26 W.; 575 feet west of house on north side of road, on south edge of road. Ground elevation, 2,573 feet (a); depth to water, caved at 190.6 feet, September 15, 1941.

SOIL and yellowish buff silt (Peorian) - - - - -	29	29
SOIL, clayey, dark reddish brown (Loveland) - - - - -	1	30
SILT, clayey, brownish buff - - -	3	33
SILT, clayey, limy, light yellowish; less limy with depth - - -	6	39
SILT, clayey, very limy, nearly white - - - - -	2	41
SILT, reddish; less clay, some soil	5	46
SILT, firm, massive, brown; somewhat sandy - - - - -	3	49
SILT, clayey, limy, soft, light gray	3	52
SILT, sandy, slightly reddish brown	14	66
SILT, clayey, limy, light yellow	2	68
SILT, clayey, light buff - - - -	6	74
SILT, clayey, limy, light buff -	3	77
SILT, clayey, reddish brown - - -	1	78
SILT, clayey, limy, light gray -	1	79
CLAY, reddish brown, silt (Loveland)	4	83
SILT, clayey, sandy, limy, whitish buff (Ogallala) - - - - -	2	85
SANDSTONE, fine, limy, hard, greenish gray - - - - -	1	86
LIMESTONE, hard, dense, white; or indurated limy clay - - - - -	1	87
SAND, fine, soft, silty, light green	7	94
SILT and clay, limy, sandy, light grayish white - - - - -	2	96
SANDSTONE, limy, fine, silty, light grayish brown - - - - -	2	98
SANDSTONE, silty, fine, light gray; concretions of light gray dense, hard brittle lime, some sand -	4	102
SANDSTONE, hard, fine, brown - -	1	103
SANDSTONE, fine, silty, hard, limy, whitish gray; some dense compact lime - - - - -	1	104
SILT, clayey, grayish whitish greenish; compact but softer, some sand	3	107
SILT, compact, white grayish green; some sand grains - - - - -	17	124
SANDSTONE, soft, light brown; fine silty gravel - - - - -	3	127
SANDSTONE, dense, light grayish brown; similar to that above but very hard - - - - -	4	131
SANDSTONE, fine, brown; hard and compact - - - - -	5	136
SILT, limy, clayey, light or whitish gray; fine sand grains 137 to 139 feet, hard translucent lime or limy clay - - - - -	3	139

RED WILLOW COUNTY

	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
SAND, silty, soft, brown; some hard brown sandstone and perhaps concretions of harder material - - -	2	141	ROAD FILL - - - - -	1	1
SAND, fine, soft, grayish brown; some translucent limy hard bodies	39	180	CLAY, dark buff - - - - -	22	23
SAND, coarse, pale pink and pale green; similar to above - - - -	6	186	GRAVEL, medium, red; good, clean -	19	42
CLAY, soft, limy, white; hard translucent brittle masses, probably concretions - - - - -	6	192	CLAY, hard, tan - - - - -	1	43
SAND, fine, silty, light greenish gray to 196 feet; less limy, greener to 198 feet; less limy, greenish gray to 202 feet; limy, nearly white to 207 feet; less lime to 208 feet; harder where most limy, some concretions - - -	16	208	GRAVEL, medium, red; some clay and chalky material - - - - -	4	47
GRAVEL, medium to coarse, well-sorted; much clear quartz, some green, red and black pebbles, sharp, slightly finer and greener below - - - -	29	237	CLAY, sandy, tan - - - - -	5	52
SILT, clayey, sandy, soft, limy, light or whitish green - - - -	1	238	GRAVEL, coarse, red; some clay and broken limestone, hard brittle rock at 52 to 53 feet, buff to rusty color - - - - -	22	74
GRAVEL, poorly sorted, or rubble of chipped chert from Niobrara and other hard angular fragments of ill sorted size - - - - -	3	241	CHALK, cream colored, light tan, pink - - - - -	9	83
CLAY, tan and olive green; some pebbles - - - - -	1	242	SHALE, khaki colored, olive drab -	6	89
GRAVEL, fine; some sharp fragments	9	251	35. NW $\frac{1}{4}$ Sec. 1, T.1 N., R.26 W.; 300 feet north of C. B. & Q. railroad, on east edge of road. Ground elevation, 2,356 feet (a); depth to water, 14.3 feet, August 25, 1941.		
CHERT, yellowish tan, at top of Niobrara - - - - -	1	252	ROAD FILL and dark brown clay - - -	5	5
33. Sec. 36, T.2 N., R.26 W.; 0.45 mile south of northeast corner of section, east of row of cottonwood trees, on west edge of road. Ground elevation, 2,348 feet (a); depth to water, 23.9 feet, August 4, 1941.			CLAY, khaki brown; not very compact	4	9
ROAD FILL and dark brown clay - - -	13	13	CLAY, sandy, dark brown - - - -	8	17
CLAY, sticky, soft, buff; sandy and softer in lower part - - - -	23	36	CLAY, sandy, light gray; somewhat granular - - - - -	5	22
GRAVEL, medium, coarse, loose, good, red - - - - -	8	44	GRAVEL, medium, reddish green; not very compact - - - - -	17	39
CLAY, sandy, compact, light buff -	1	45	GRAVEL, medium, compact, green; contains compact green argillaceous sands - - - - -	16	55
GRAVEL, medium, coarse, red; some clay and lime, compact - - - -	5	49	GRAVEL, medium, green; intermingled with very compact calcareous clays	10	65
CLAY, sandy, light grayish tan; some gravel - - - - -	4	53	ROCK - - - - -	0	65
CLAY, like above but darker in color	10	63	36. Southeast corner of SE $\frac{1}{4}$ Sec. 2, T.1 N., R.26 W.; 35 feet north of north end of bridge, on west edge of road. Ground elevation, 2,349 feet (a); depth to water, 6 feet, August 25, 1941.		
CLAY, sandy, hard, cream colored to light tan; some gravel, probably cave - - - - -	8	71	ROAD FILL, black - - - - -	5	5
ROCK, hard, brittle, and coarse gravel, yellowish - - - - -	4	75	CLAY, dark brown - - - - -	4	9
CLAY, sandy, rusty tan with rusty streaks; compact, sticky - - - -	16	91	GRAVEL, fine to medium, reddish and white - - - - -	7	16
ROCK, hard, solid, chips greenish; too hard to drill, flinty - - - -	0	91	GRAVEL, coarse, red - - - - -	12	28
34. Northeast corner of Sec. 1, T.1 N., R.26 W.; in line with west edge of north and south road, on south edge of road. Ground elevation, 2,347 feet (a); depth to water, 19.1 feet, August 4, 1941.			CLAY, sandy, greenish gray - - - -	6	34
			GRAVEL, medium to coarse; some pebbles - - - - -	12	46
			SAND, argillaceous; some limy material and medium gravel, quite compact	9	55
			CLAY, arenaceous, very compact, greenish gray - - - - -	12	67
			SHALE, buff - - - - -	1	68
			SHALE, very compact, dark khaki colored - - - - -	1	69
			37. Southeast corner of NW $\frac{1}{4}$ Sec. 10, T.1 N., R.26 W.; 240 feet west of C. B. & Q. railroad, on north edge of road. Ground elevation, 2,378 feet (a); depth to water, 24.3 feet, August 25, 1941.		
			ROAD FILL and dark brown clayey sand - - - - -	6	6
			SAND, clayey, soft, brown to buff -	10	16
			SAND, clayey, soft, light brown - -	10	26

	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
SAND and gravel, fine; poor sample	3	29	41. NW $\frac{1}{4}$ Sec. 17, T.1 N., R.26 W.; 0.3 mile west		
GRAVEL, fine to coarse, red; fairly compact	6	35	of southeast corner of quarter, 430 feet west of		
SAND, cemented, brownish; cuts in chips, resembles sandstone	7	42	Beaver Creek bridge, on north edge of road.		
CLAY, sandy, brown to greenish	2	44	Ground elevation, 2,392 feet (a); depth to water,		
SAND, cemented, gray; hard, compact, practically sandstone	6	50	10.2 feet, August 25, 1941.		
ROCK, flint, hard, tan	0	50	ROAD FILL	4	4
38. NW $\frac{1}{4}$ Sec. 16, T.1 N., R.26 W.; 180 feet north			SAND, clayey, silty, soft, brownish buff	5	9
of southwest corner, on east edge of road. Ground			GRAVEL, fine to coarse, reddish	8	17
elevation, 2,390 feet (a); depth to water, 23.5			GRAVEL, fine to medium, some coarse, gray; some silt	7	24
feet, August 25, 1941.			SILT, gray	1	25
ROAD FILL	2	2	GRAVEL, coarse, gray	4	29
SAND, clayey, buff	6	8	SILT, gray	2	31
SAND, coarse; cemented with pinkish buff clay	5	13	GRAVEL, fine to coarse, brown rusty gray; some water-worn shale, flint, loose	5	36
SAND, coarse, and fine gravel, compact	3	16	GRAVEL, compact, brown; much water-worn shale, lime; flint	3	39
GRAVEL, fine to coarse, compact; contains water-worn limy shale	4	20	SHALE, tough, khaki colored to gray; very sticky	10	49
GRAVEL, fine to coarse, reddish; clean, compact	6	26	42. SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 17, T.1 N., R.26 W.; 150 feet		
GRAVEL, coarse; some flinty boulders, very hard	2	28	south of northeast corner of forty, on west		
ROCK, flint, tan; very hard, drilled only a little over one inch in 20 minutes	0	28	edge of road. Ground elevation, 2,419 feet (a);		
39. SE $\frac{1}{4}$ Sec. 16, T.1 N., R.26 W.; 120 feet south			depth to water, 20 feet, August 25, 1941.		
of northeast corner of section, on west edge of			ROAD FILL and dark brown sandy clay	6	6
road. Ground elevation, 2,400 feet (a); depth			CLAY, sandy, dark brown to black	5	11
to water, 33.9 feet, August 25, 1941.			SAND, clayey, chocolate brown	2	13
CLAY, blackish brown	2	2	CLAY, brown to buff	1	14
CLAY, sandy, dark buff; fairly compact	34	36	CLAY, silty, sandy, buff	30	44
GRAVEL, medium to coarse, reddish brown; quite compact	11	47	GRAVEL, fine to coarse, red; fairly compact	10	54
CLAY, buff	12	59	CLAY, sandy, brownish buff to rusty	2	56
CLAY, very sandy, buff; compact, like sandstone	5	64	GRAVEL, fine to coarse, reddish; fairly compact	9	65
CLAY, limy, quite hard, khaki colored	5	69	GRAVEL, coarse; some red flinty to calcareous shale boulders	2	67
GRAVEL, argillaceous, limy, brown	12	81	CLAY, sandy, compact, grayish green	7	74
ROCK, flinty, very hard	0	81	SHALE, white to cream colored to pink the last few feet; sticky	5	79
40. NE $\frac{1}{4}$ Sec. 17, T.1 N., R.26 W.; 0.3 mile north			43. Northeast corner of NW $\frac{1}{4}$ Sec. 26, T.4 N., R.		
of southeast corner of quarter, 250 feet south			27 W.; 390 feet west of bridge, on south edge of		
of Beaver Creek bridge, on west edge of road.			road. Ground elevation, 2,396 feet (a); depth		
Ground elevation, 2,379 feet (a); depth to water,			to water, 23.6 feet, August 4, 1941.		
14 feet, August 25, 1941.			ROAD FILL	3	3
ROAD FILL and gray brown clayey sand	6	6	CLAY, sandy, buff	27	30
GRAVEL, fine, reddish; compact, poor	12	18	CLAY; some red gravel	7	37
GRAVEL, fine to coarse, greenish gray	8	26	GRAVEL, very coarse, red; good, clean	5	42
CLAY or shale, black, silty	2	28	GRAVEL, coarse, red; lime and clay	13	55
SHALE, calcareous, khaki colored to pink; breaks in chips, very hard, some flint chips	2	30	LIME and gravel	15	70
SHALE, tannish rusty to white to pink	9	39	CLAY, sandy, tan, salmon like cast	26	96
SHALE, ochre colored	4	43	SHALE, soft, yellow ochre colored	3	99
FLINT, rusty to reddish	1	44	44. SE $\frac{1}{4}$ Sec. 26, T.4 N., R.27 W.; 0.4 mile north		
SHALE, tan	4	48	of southeast corner of section, 100 feet north of		
SHALE, pink to brick red	1	49	bridge over creek, on west edge of road. Ground		
			elevation, 2,389 feet (a); depth to water, 29.8		
			feet, August 4, 1941.		
			ROAD FILL and wash	4	4
			CLAY, sandy, buff	23	27
			GRAVEL, red; poor, some organic matter and clay	5	35

22X 1100 2400
26500

RED WILLOW COUNTY

Thick-
ness
(feet)

Depth
(feet)

GRAVEL, medium, red; fair, much lime
and some clay - - - - - 4 39
GRAVEL, medium, red; very much limy
material, hard or compact - - - - - 18 57
SHALE, cream colored, tan to greenish - - - - - 2 59

45. SW $\frac{1}{4}$ Sec. 36, T.4 N., R.27 W.; 0.35 mile east
of southwest corner of section, on north edge of
road. Ground elevation, 2,368 feet (t); depth
to water, 29.5 feet, August 4, 1941.

ROAD FILL, black - - - - - 6 6
CLAY, sandy, dark buff - - - - - 14 20
CLAY, more sandy than above, buff - - - - - 15 35
SILT, powder blue; many snail shells,
may be from above - - - - - 22 57
GRAVEL, very coarse, red; good - - - - - 11 68
SHALE, tan - - - - - 1 69

46. SE $\frac{1}{4}$ Sec. 36, T.4 N., R.27 W.; 0.2 mile east
of southwest corner of quarter, 125 feet west
of creek, on north edge of road. Ground ele-
vation, 2,355 feet (t); depth to water, 27.9
feet, August 4, 1941.

ROAD FILL - - - - - 5 5
CLAY, sandy, buff - - - - - 25 30
CLAY, sandy, grayish brown - - - - - 6 36
SILT, dark, bluish gray - - - - - 14 50
SILT, light, blue, some wood - - - - - 7 57
CLAY and silt, buff - - - - - 3 60
GRAVEL, red, and clay, poor - - - - - 5 65
SHALE, cream colored, tan and yellow - - - - - 4 69

47. Northeast corner of SE $\frac{1}{4}$ Sec. 1, T.3 N., R.27
W.; 75 feet south of intersection, on west edge
of road. Ground elevation, 2,358 feet (t);
depth to water, caved at 28.5 feet, August 4,
1941.

ROAD FILL and grayish brown clay - - - - - 10 10
CLAY, sandy, buff - - - - - 15 25
GRAVEL, medium to coarse, red; good,
about one-fourth blackish gravel - - - - - 10 35
GRAVEL, medium to coarse, red; good,
clean - - - - - 10 45
SHALE, soft, tan with some yellow
ochre - - - - - 4 49

48. SE $\frac{1}{4}$ Sec. 2, T.3 N., R.27 W.; 0.1 mile south
of northeast corner of quarter, 0.12 mile south
of cross road, on west edge of road. Ground
elevation, 2,355 feet (t); depth to water,
20.8 feet, August 4, 1941.

ROAD FILL and sandy clay, dark brown - - - - - 7 7
CLAY, sandy, buff - - - - - 11 18
GRAVEL, medium, red; good, loose,
clean - - - - - 9 27
SHALE, soft, tan - - - - - 13 40
SHALE, harder than above, yellow ochre - - - - - 9 49

49. SW $\frac{1}{4}$ Sec. 2, T.3 N., R.27 W.; 0.23 mile north
of southwest corner of quarter, on east side of
highway. Ground elevation, 2,358 feet (t);
depth to water, 19.2 feet, September 8, 1941.

Probe check samples
Prob not shale
according to int. test data
1967, SW $\frac{1}{4}$ Sec. 25

9

Thick-
ness
(feet)

Depth
(feet)

ROAD FILL - - - - - 4 4
CLAY, sandy, slate brown; containing
some calcareous fossilized material - - - - - 7 11
SILT, sandy, brownish black - - - - - 3 14
CLAY, sandy, buff gray - - - - - 2 16
GRAVEL, medium, reddish brown; not
very compact - - - - - 5 21
GRAVEL, medium to coarse; some grains
covered with black carbonaceous
material - - - - - 1 22
CLAY, light khaki, and coarse to
medium gravel, brown - - - - - 1 23
SHALE, yellowish brown - - - - - 2 25
SHALE, olive drab - - - - - 4 29

50. SE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 8, T.3 N., R.27 W.; 0.1 mile
north of southeast corner, on west side of road.
Ground elevation, 2,373 feet (t); depth to water,
25.1 feet, September 16, 1941.

SAND, dark gray to drab, soil - - - - - 13 13
SOIL, sandy, clayey, light buff - - - - - 7 20
GRAVEL, fine to medium coarse, red - - - - - 17 37
SAND, fine - - - - - 8 45
GRAVEL, medium, red; some fine
sand - - - - - 4 49
CLAY, greenish yellow - - - - - 2 51
CLAY, greenish gray; some green
gravel - - - - - 7 58
GRAVEL, medium to coarse, red - - - - - 4 62
GRAVEL, medium to coarse, green - - - - - 1 63
SHALE, buff to gray - - - - - 6 69

51. NW $\frac{1}{4}$ Sec. 10, T.3 N., R.27 W.; 0.25 mile south
of northwest corner of quarter, on east side of
road. Ground elevation, 2,355 feet (t); depth
to water, 11.9 feet, September 8, 1941.

SILT, sandy, gray - - - - - 9 9
SAND, fine; some clay streaks - - - - - 3 12
GRAVEL, fine to medium, gray - - - - - 8 20
GRAVEL, fine to medium, red - - - - - 21 41
SAND, fine, red - - - - - 23 64
SAND, medium to fine - - - - - 3 67
SHALE, gray speckled, some buff - - - - - 2 69

52. Northwest corner of NE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 10, T.3 N.,
R.27 W.; about 30 feet south of corner. Ground
elevation, 2,356 feet (t); depth to water, 4.7
feet, September 8, 1941.

SAND, silty - - - - - 2 2
GRAVEL, fine, brownish red - - - - - 5 7
GRAVEL, fine to medium, grayish
green - - - - - 10 17
GRAVEL, fine to medium; some fine
sand - - - - - 2 19
GRAVEL, same as above but sand not
so evident - - - - - 2 21
GRAVEL, fine, brown; some fine sand - - - - - 3 24
GRAVEL, medium, brownish red - - - - - 8 32
GRAVEL, fine, brown; some fine sand - - - - - 5 37
GRAVEL, medium, brown - - - - - 3 40
SAND, fine, brown; some reddish
brown gravel - - - - - 5 45

	Thick- ness (feet)	Depth (feet)
GRAVEL, fine to medium, reddish brown; some fine sand - - - - -	10	55
SAND, fine, brown - - - - -	10	65
SHALE, dark olive gray - - - - -	4	69

53. Southwest corner of NE $\frac{1}{4}$ SE $\frac{1}{4}$, Sec. 10, T.3 N., R.27 W.; 216 feet north and 66 feet west of windmill, just east of north and south fence. Ground elevation, 2,340 feet (t); depth to water, 6.5 feet, September 8, 1941.

SAND, fine, and sandy soil - - - - -	4	4
GRAVEL, fine, medium, coarse, brown	5	9
GRAVEL, coarse, grayish green; streaks of gray clay - - - - -	3	12
GRAVEL, medium to fine, green to gray; some limy pebbles - - - - -	23	35
GRAVEL, medium to fine, red - - - - -	15	50
SAND, very fine, red to gray - - - - -	13	63
GRAVEL, medium to fine, red - - - - -	2	65
SHALE, brown - - - - -	1	66

54. SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 10, T.3 N., R.27 W.; 140 feet north of southwest corner of forty, on east side of fence. Ground elevation, 2,338 feet (t); depth to water, 5.6 feet, September 15, 1941.

SAND, fine, silty, brown - - - - -	2	2
GRAVEL, fine, brown; not compact - - - - -	6	8
GRAVEL, fine to medium, green and brown intermingled - - - - -	1	9
GRAVEL, medium to coarse, green - - - - -	4	13
GRAVEL, fine, green - - - - -	1	14
GRAVEL, medium to coarse, greenish brown - - - - -	3	17
GRAVEL, fine to medium, greenish brown; some fine sand from 19 to 25 feet - - - - -	8	25
GRAVEL, fine to medium, brown; some fine sand throughout - - - - -	15	40
SHALE, brownish olive drab - - - - -	9	49

55. NW $\frac{1}{4}$ Sec. 11, T.3 N., R.27 W.; 0.1 mile south of northwest corner of quarter, on east edge of road. Ground elevation, 2,336 feet (t); depth to water, 4.4 feet, September 8, 1941.

ROAD FILL and buff sand - - - - -	5	5
GRAVEL, fine to medium, red - - - - -	5	10
GRAVEL, fine to coarse, red; good - - - - -	13	23
SHALE, hard, dark gray to black, white specks - - - - -	6	29

56. NW $\frac{1}{4}$ Sec. 11, T.3 N., R.27 W.; 350 feet north of southwest corner of quarter, on east side of road. Ground elevation, 2,339 feet (t); depth to water, 5.1 feet, September 8, 1941.

SOIL, sandy, and fine to coarse red gravel - - - - -	9	7
GRAVEL, fine to coarse, grayish red; very good - - - - -	9	16
GRAVEL, fine to coarse, red; good - - - - -	5	21
GRAVEL, mostly coarse, red; good, some water-worn lime (Ogallala) - - - - -	8	29
GRAVEL, fine to medium, some coarse, slightly compact; some water-worn shale and water-worn limy material (Ogallala) - - - - -	13	42

SHALE, khaki to olive brown colored	3	45
SHALE, compact, dark gray - - - - -	2	47

57. SW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 11, T.3 N., R.27 W.; 240 feet south of northwest corner of forty, 20 feet east of fence. Ground elevation, 2,335 feet (t); depth to water, 4.6 feet, September 8, 1941.

SOIL, sandy, fine, and fine sand - - - - -	4	4
GRAVEL, fine, medium, coarse, greenish grayish red; good, clean - - - - -	14	18
SAND, fine; some fine to medium gravel, loose - - - - -	7	25
GRAVEL, fine to medium, some coarse, red; very loose, good - - - - -	5	30
GRAVEL, fine to medium, some coarse, much fine, red - - - - -	10	40
GRAVEL, fine to medium, red; very loose, drilled like coarse gravel, very good - - - - -	24	64
SHALE, tough, dark olive gray to almost black - - - - -	2	66

58. SW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 13, T.3 N., R.27 W.; 0.2 mile east of west line of section, 100 feet east of bridge over drainage, on north edge of road. Ground elevation, 2,355 feet (t); depth to water, 30.6 feet, September 8, 1941.

ROAD FILL - - - - -	4	4
LOAM, clayey, blackish brown - - - - -	6	10
CLAY, sandy, blackish brown - - - - -	6	16
CLAY, sandy, dark khaki brown - - - - -	12	28
GRAVEL, medium, brown; quite porous; clay seam at 36 feet about 6 inches thick - - - - -	12	40
CLAY, sandy, light brown; some medium brown gravel, quite compact - - - - -	7	47
CLAY, sandy, calcareous; mixed with medium brown gravel, quite compact - - - - -	3	50
CLAY, sandy, and medium brown gravel, compact - - - - -	9	59
GRAVEL, medium, reddish brown - - - - -	2	61
SHALE, buff - - - - -	1	62
SHALE, buff gray - - - - -	3	65

59. NW $\frac{1}{4}$ Sec. 14, T.3 N., R.27 W.; 0.12 mile west of bridge over drainage, 0.55 mile west of road to south, on north edge of road, just east of trail to south. Ground elevation, 2,359 feet (t); depth to water, 28.5 feet, September 4, 1941.

ROAD FILL, grayish black loam - - - - -	9	9
LOAM, clayey, dark gray - - - - -	5	14
CLAY, slightly sandy, buff to tan - - - - -	15	29
GRAVEL, fine to medium, reddish - - - - -	8	37
GRAVEL, medium to coarse - - - - -	3	40
GRAVEL, fine, white to red - - - - -	15	55
GRAVEL, medium to coarse, red - - - - -	6	61
GRAVEL, fine to medium, buff to gray; some sandy limy clay - - - - -	9	70
LIME, light buff; some gravel - - - - -	5	75
SHALE, limy, buff to gray - - - - -	3	78
SHALE, olive drab - - - - -	1	79

60. NE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 16, T.3 N., R.27 W.; 150 feet west of bridge, on south side of road. Ground elevation, 2,359 feet (t); depth to water, 16.3 feet, September 30, 1941.

SOIL and road fill, silty, brown - -	7	7
CLAY, light buff, yellow; some limy streaks - - - - -	17	24
SILT, sandy, grayish buff; compact, some streaks of magnetite - - - -	11	35
SAND, shaly, brownish green; some streaks of compact brownish green shale - - - - -	1	36
CLAY, limy, white to buff gray - - -	3	39
GRAVEL, medium to coarse, green - - -	8	47
CLAY, light yellow - - - - -	3	50
SHALE, light gray to buff - - - - -	5	55
SHALE, olive drab to chocolate brown -	4	59

61. NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 17, T.3 N., R.27 W.; 0.05 mile west of southeast corner of forty, on south side of road. Ground elevation, 2,362 feet (t); depth to water, 10.3 feet, September 30, 1941.

ROAD FILL and dark gray soil - - -	7	7
SAND, silty, fine - - - - -	4	11
SAND, fine, and fine red gravel - -	2	13
GRAVEL, fine to coarse, clean, red	4	17
GRAVEL, coarse, red; streaks of medium gray to black sandy silt -	3	20
GRAVEL, medium to coarse, clean, red - - - - -	5	25
SAND, medium, and coarse red gravel	2	27
SAND, very fine, red - - - - -	18	45
GRAVEL, medium to coarse, red - - -	2	47
SAND, very fine, red - - - - -	11	58
GRAVEL, medium, green; some pieces of yellow to ochre colored shale	7	65
GRAVEL, coarse, red; some light yellow to yellowish gray sandy clay - - - - -	6	71
SHALE, dark olive drab to yellowish green - - - - -	3	74
SHALE, dark gray - - - - -	3	77

62. NW $\frac{1}{4}$ Sec. 18, T.3 N., R.27 W.; 700 feet south of northeast corner of quarter, on west edge of road. Ground elevation, 2,375 feet (t); depth to water, 10 feet, September 23, 1941.

ROAD FILL and dark brown soil - - -	6	6
CLAY, sandy, silty, buff - - - - -	8	14
SAND and fine gravel, roddish brown	4	18
GRAVEL, fine to medium, mostly gray; some gray silt, dirty - - - - -	9	27
GRAVEL, coarse, grayish red - - -	2	29
GRAVEL, fine to medium, very loose, red - - - - -	8	37
GRAVEL, coarse, red; flint boulders at 37 feet - - - - -	2	39
SHALE, hard, steel gray, white specks	6	45

63. NE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 18, T.3 N., R.27 W.; 0.1 mile south of northwest corner of forty, on east edge of road. Ground elevation, 2,370 feet (t); depth to water, caved at 7 feet, September 23, 1941.

ROAD FILL and brown soil - - - - -	5	5
CLAY, silty, light brown - - - - -	3	8
GRAVEL, fine to coarse, red - - - -	17	25
GRAVEL, fine to medium - - - - -	24	49
SAND, very fine, gray to red; some fine shale particles, probably shale at 59 feet - - - - -	10	59

64. SW $\frac{1}{4}$ Sec. 18, T.3 N., R.27 W.; 110 feet east of road intersection, south of river bridge, on north edge of road. Ground elevation, 2,372 feet (t); depth to water, caved at 9.2 feet, September 30, 1941.

ROAD FILL and brown sandy soil - -	6	6
SOIL, light brown to buff - - - - -	2	8
SOIL, sandy, gray - - - - -	1	9
GRAVEL, fine to medium, clean, red	4	13
GRAVEL, medium to coarse, gray; some gray sandy clay streaks, dirty -	2	15
CLAY, sandy, gray - - - - -	4	19
SAND, fine, red - - - - -	4	23
GRAVEL, medium to coarse, clean, red	6	29
SAND, fine, red - - - - -	4	33
GRAVEL, medium to fine, red; some fine sand - - - - -	7	40
SHALE, medium, grayish buff to black	6	46

65. SW $\frac{1}{4}$ Sec. 9, T.1 N., R.27 W.; 0.15 mile north of southwest corner of section, 65 feet south of Beaver Creek bridge, on east edge of road. Ground elevation, 2,439 feet (a); depth to water 11.8 feet, August 25, 1941.

ROAD FILL - - - - -	2	2
SAND, silty, clayey, soft, brown -	17	19
GRAVEL, fine to medium, grayish red; thin gray silt layer at 25 feet -	9	28
SILT, gray - - - - -	2	30
GRAVEL, fine to coarse, greenish gray	6	36
CLAY, compact, tannish pink - - -	6	42
LIME, soft, very white - - - - -	6	48
CLAY, tough, compact, light grayish tan - - - - -	7	55
SAND, clayey, greenish gray; some coarse sand, soft - - - - -	5	60
CLAY, slightly sandy, compact, gray	10	70
SHALE, compact, tannish yellow for about one foot, then khaki colored to dark olive brown - - - - -	4	74

66. SW $\frac{1}{4}$ Sec. 11, T.1 N., R.27 W.; 0.2 mile north of southwest corner of section, 40 feet south of north edge of cemetery, on east edge of road. Ground elevation, 2,446 feet (a); depth to water caved at 10 feet, August, 1941.

ROAD FILL - - - - -	4	4
CLAY, silty, sandy, buff - - - - -	22	26
CLAY, sandy, reddish buff - - - - -	5	31
SAND, clayey, limy, light gray - -	3	34
GRAVEL, fine to coarse, red - - - -	4	38
ROCK, flinty, rusty - - - - -	1	39
ROCK, flint, hard, red - - - - -	1	40

RED WILLOW COUNTY

67. SE $\frac{1}{4}$ Sec. 12, T.1 N., R. 27 W.; 0.10 mile north of southwest corner of quarter, 0.6 mile north of highway, on east side of road. Ground elevation, 2,404 feet (a); depth to water, 7.1 feet, August 25, 1941.

	Thick- ness (feet)	Depth (feet)
ROAD FILL - - - - -	4	4
CLAY, blackish brown - - - - -	6	10
GRAVEL, fine to medium, brownish red	10	20
GRAVEL, fine to medium, fairly com- pact, green - - - - -	5	25
GRAVEL, coarse, green and red - - -	4	29
GRAVEL, medium, greenish - - - - -	2	31
CLAY, fairly compact, yellowish orange - - - - -	8	39
GRAVEL, medium, greenish - - - - -	2	41
CLAY, fairly compact, ochre yellow	4	45
CLAY, salmon pink; quite compact, shale ? - - - - -	7	52
CLAY, ochre yellow; quite compact, shale ? - - - - -	15	67
SHALE, olive drab - - - - -	2	69

68. NW $\frac{1}{4}$ Sec. 13, T.1 N., R. 27 W.; 295 feet north of C. B. & Q. railroad, on west edge of road. Ground elevation, 2,409 feet (a); depth to water, 16.5 feet, August 25, 1941.

ROAD FILL, dark brown clayey material	9	9
CLAY, buff; very slightly sandy - -	8	17
SAND, fine to medium, reddish cast	10	27
GRAVEL, medium to coarse, white and green - - - - -	5	32
CLAY, sandy, hard, buff - - - - -	3	35
GRAVEL, medium to coarse; some pebbles - - - - -	6	41
CLAY, yellow ochre to bright orange	22	63
SHALE, brown khaki colored - - - -	3	66
SHALE, black - - - - -	1	67

69. NE $\frac{1}{4}$ Sec. 15, T.1 N., R. 27 W.; 0.15 mile south of northeast corner of section, 50 feet south of steel bridge over old channel of creek, on west edge of road. Ground elevation, 2,426 feet (a); depth to water, 11 feet, August 25, 1941.

ROAD FILL and dark brown clayey sand	5	5
CLAY, silty, sandy, brown - - - - -	6	11
SAND, silty, brown; many fossil stems	6	17
SILT and gravel, gray - - - - -	4	21
GRAVEL, fine to coarse, grayish green	9	30
CLAY, silty, black - - - - -	2	32
GRAVEL, fine to coarse, loose, green- ish grayish red - - - - -	8	40
SHALE, ochre to yellow to red - - -	7	47
SHALE, red - - - - -	2	49

70. NW $\frac{1}{4}$ Sec. 16, T.1 N., R. 27 W.; 0.25 mile north of railroad, on east edge of road. Ground elevation, 2,437 feet (t); depth to water, 8.9 feet, August 25, 1941.

ROAD FILL - - - - -	4	4
CLAY, sandy, brownish buff - - - -	4	8
SAND and gravel, fine, reddish - -	8	16
GRAVEL, fine to medium, greenish gray - - - - -	3	19
GRAVEL, gray; much silty clay, wood fragments at 19 feet - - - - -	7	26

GRAVEL, fine to coarse, loose, grayish red - - - - -	8	34
CLAY, hard, sticky, greenish gray -	2	36
CLAY, tough, sticky, tan - - - - -	2	38
CLAY, sandy, reddish brown; hard, looks like sandstone - - - - -	5	43
CLAY, sandy, compact, brownish gray	5	48
CLAY, tough, sticky, greenish gray	12	60
CLAY, tough, sticky, greenish gray; tougher than above - - - - -	6	66
SHALE, tan to green - - - - -	1	67
SHALE, tough, khaki colored to dark brownish black - - - - -	2	69

71. SW $\frac{1}{4}$ Sec. 16, T.1 N., R. 27 W.; 0.1 mile north of southwest corner of section, 315 feet north of concrete bridge over small drainage, 0.4 mile south of railroad, on east edge of road. Ground elevation, 2,460 feet (a); depth to water, 27.9 feet, August 25, 1941.

ROAD FILL - - - - -	4	4
CLAY, sandy, brown to buff - - - -	23	27
SAND, silty, gray; rusty streaks -	22	49
SAND and gravel, fine, very compact, silty - - - - -	7	56
GRAVEL, fine to coarse, slightly compact, red - - - - -	13	69
CLAY, greenish gray; some embedded fine gravel, tough, sticky - - -	13	82
CLAY, greenish gray, dark green streaks; tough, sticky, shale ? -	3	85
SHALE, tough, khaki colored to dark brownish - - - - -	3	88

72. SW $\frac{1}{4}$ Sec. 17, T.1 N., R. 27 W.; 0.48 mile north of southwest corner of section, 390 feet south of bridge over small drainage, on west edge of road. Ground elevation, 2,453 feet (a); depth to water, 9.5 feet, August 25, 1941.

ROAD FILL - - - - -	4	4
SAND, silty, soft, brown - - - - -	10	14
SAND, and fine gravel, silty - - -	3	17
GRAVEL, fine to coarse, greenish and red, silty clay layer at 24 feet	16	33
GRAVEL, fine to coarse; black and gray silt, either thin seams or present throughout - - - - -	4	37
GRAVEL, coarse, loose, brownish gray	7	44
GRAVEL, fine to coarse, brown, good	6	50
SAND and fine gravel, red; limy sand concretions, caliche sand grains cemented with lime, fairly loose	21	71
CLAY, sandy, compact, light brown to tan to gray - - - - -	6	77
SHALE, ochre to light grayish tan at base - - - - -	2	79

73. SW $\frac{1}{4}$ Sec. 18, T.1 N., R. 27 W.; 0.4 mile east of southwest corner of section, 270 feet west of farm lane to the north, on north edge of road. Ground elevation, 2,453 feet (a); depth to water, 3.4 feet, August 28, 1941.

ROAD FILL - - - - -	3	3
SAND, silty, soft, brown - - - - -	5	8
SAND, silty, soft, brownish gray -	6	14
GRAVEL, fine to medium, loose, red	6	20

	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
GRAVEL, fine to medium, greenish, red; dirty, silty clay layer at 20 feet - - - - -	8	28	SOIL, silty, brown - - - - -	16	16
SILT, black - - - - -	2	30	SOIL, sandy, medium, gray - - - - -	13	29
GRAVEL, fine to coarse, reddish gray, good, loose - - - - -	7	37	GRAVEL, fine to very coarse, red; no clay breaks - - - - -	42	71
SHALE, weathered, light green - - -	1	38	SAND, very fine; hard substance at 78 feet - - - - -	7	78
SHALE, ochre, a few red streaks - -	7	45			
SHALE, khaki to dark olive brown -	3	48			
74. SE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 19, T.1 N., R.27 W.; 315 feet west of railroad, on east and west road just west of highway, on north side of road. Ground elevation, 2,461 feet (a); depth to water, 13.6 feet, August 28, 1941.			77. Northwest corner of NE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 32, T.4 N., R.28 W.; just east of entrance to field, on south side of road. Ground elevation, 2,586 feet (a); depth to water, 136.6 feet, September 23, 1941.		
ROAD FILL - - - - -	3	3	ROAD FILL - - - - -	3	3
CLAY, silty, brownish black - - - -	7	10	SILT, sandy, buff (Peorian) - - - -	13	16
CLAY, sandy, brownish black - - - -	14	24	SILT, sandy, buff (Peorian); fossil roots, stems, gastropod shells -	3	19
CLAY, sandy, brownish black; some fossilized material - - - - -	7	31	SILT, buff, fine silty sand (Peorian)	20	39
GRAVEL, medium, reddish brown; not very compact - - - - -	7	38	SILT, reddish brown, silty clay (Loveland) - - - - -	5	44
FLINTY LAYER, olive green - - - - -	1	39	SILT, limy, clayey, light tan buff; limy concretions - - - - -	21	65
GRAVEL, coarse, reddish brown; quite loose - - - - -	9	48	CLAY, silty, light reddish buff - -	19	84
SHALE, weathered, khaki brown - - -	11	59	SANDSTONE, light brown; some gravel and lime pebbles - - - - -	6	90
SHALE, olive drab - - - - -	6	65	CLAY, silty, reddish buff; compact, some limy - - - - -	10	100
SHALE, black - - - - -	3	68	CLAY, silty, reddish buff; much lime, limy concretions - - - - -	3	103
75. SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 23, T.4 N., R.28 W.; approxi- mately on south center line of forty, about 100 feet west of bridge, on north side of road. Ground elevation, 2,457 feet (a); 27.7 feet, October 7, 1941.			LIMESTONE, gray; crystalline, very hard - - - - -	2	105
ROAD FILL and dark brown sandy soil	8	8	SANDSTONE, light gray, slight green- ish cast - - - - -	4	109
SOIL, sandy, black - - - - -	5	13	CLAY, sandy, hard, compact, green	5	114
CLAY, sandy, medium brown to tan -	2	15	CLAY, sandy, limy, whitish gray - -	1	115
CLAY, sandy, buff - - - - -	14	29	SANDSTONE, green; fairly compact -	5	120
CLAY, sandy, gray; small limy stem casts - - - - -	15	44	SANDSTONE, light greenish to tan to gray; porous - - - - -	15	135
SAND, medium fine, to coarse red gravel; streaks of green sandy clay at 56 feet - - - - -	16	60	SANDSTONE, hard, light tannish gray, dries whitish gray; limy in spots	20	155
SAND, fine to coarse, green - - - -	13	73	SANDSTONE, greenish gray, dries light gray; softer than above - -	9	164
CLAY, sandy, green to buff - - - -	1	74	CLAY, sandy, or clayey sand, soft, pale green - - - - -	4	168
GRAVEL, coarse, red; streaks of varicolored clay - - - - -	8	82	SAND, silty, clayey, soft, pale green; hard clay pebbles, concretions, limy clay or mudstone - - - - -	10	178
SAND, very fine, reddish gray - - -	2	84	CLAY, hard, indurated, slightly limy, dark tan when wet, dries to light tan or buff - - - - -	12	190
CLAY, sandy, green; some medium red gravel - - - - -	4	88	CLAY, sandy, soft, brown; sticky, some indurated clay seams or con- cretions - - - - -	11	201
CLAY, white to buff - - - - -	5	93	CLAY, hard, indurated, brown; cuts small pieces, small limy concre- tions - - - - -	14	215
CLAY, sandy, green; streaks of tan indurated clay - - - - -	6	99	CLAY, light brown or dark brownish buff; soft, sticky, some indurated clay seams - - - - -	22	237
Unable to add another rod, quicksand from 82 feet caving.			SAND, fine, clayey, brown, some red sand grains - - - - -	3	240
76. SE $\frac{1}{4}$ Sec. 31, T.4 N., R.28 W.; 0.2 mile west of southeast corner of section, on north edge of road. Ground elevation, 2,450 feet (a); depth to water, caved at 21 feet, October 14, 1941.			GRAVEL, fine to coarse, red; clean	25	265
			GRAVEL, fine to coarse, red; some pinkish and tan shale, not as clean as above - - - - -	4	269

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	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
FLINT, very hard, pinkish white; took approximately one half hour to drill - - - - -	1	270	CLAY, sandy, blackish brown - - - -	8	8
SHAILE, ochre to light khaki colored (Niobrara) - - - - -	6	276	CLAY, sandy, brownish black - - - -	3	11
SHAILE, dark olive brown (Niobrara)	4	280	CLAY, slightly sandy, brownish buff	4	15
			CLAY, sandy, buff gray - - - - -	9	24
78. Southwest corner of SE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 36, T.4 N., R.28 W.; north side of road. Ground elevation, 2,417 feet (a); depth to water, 21.7 feet, Sep- tember 30, 1941.			GRAVEL, brown - - - - -	1	25
			CLAY, sandy, buff gray - - - - -	1	26
ROAD FILL and brown silty soil - -	15	15	SILT, sandy, grayish black - - - -	13	39
SILT, light brown to buff; limy pieces - - - - -	10	25	SAND, fine, grayish green - - - -	1	40
SILT, light gray to medium gray; some specks - - - - -	11	36	SILT, sandy, blackish gray - - - -	6	46
CLAY, sandy, medium, grayish blue -	9	45	GRAVEL, mixed, fine - - - - -	2	48
SAND, medium to fine, and coarse red gravel - - - - -	9	54	SILT, sandy, blackish gray - - - -	4	52
CLAY, sandy, tan - - - - -	12	66	GRAVEL, mixed, fine - - - - -	2	54
SAND, fine to medium, red - - - -	4	70	SILT, sandy, blackish gray - - - -	13	67
GRAVEL, medium to coarse, green - -	4	74	GRAVEL, fine to medium, brown - -	8	75
CHERT or jasper, orange yellow; drilled one inch in 50 minutes -	0	74	GRAVEL, coarse, green - - - - -	2	77
			SHAILE, grayish black - - - - -	4	81
79. SE $\frac{1}{4}$ Sec. 5, T.3 N., R.28 W.; $\frac{1}{2}$ mile south of center line of section, on east edge of road. Ground elevation, 2,452 feet (a); depth to water, 29.7 feet, October 14, 1941.			82. SW $\frac{1}{4}$ Sec. 12, T.3 N., R.28 W.; 51 feet north and 57 feet east of southwest corner of section, on north side of highway. Ground elevation, 2,406 feet (t); depth to water, 30.1 feet, September 15, 1941.		
			SOIL, sandy, brown - - - - -	25	25
			SOIL, light brown - - - - -	3	28
			GRAVEL, fine to medium coarse, red	12	40
			SHAILE, limy, white - - - - -	1	41
			SHAILE, light green - - - - -	7	48
			SHAILE, yellow - - - - -	7	55
			SHAILE, yellowish gray - - - - -	14	69
ROAD FILL and black sandy soil - -	8	8	83. Northeast corner of SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 16, T.3 N., R.28 W.; 75 feet south of creek bridge, on west side of road. Ground elevation, 2,405 feet (t); depth to water, 8.8 feet, October 27, 1941.		
SOIL, sandy, medium, brown - - - -	2	10	ROAD FILL and medium brown sandy soil - - - - -	8	8
CLAY, sandy, tan - - - - -	20	31	GRAVEL, medium to coarse, green - -	3	11
CLAY, sandy, grayish buff - - - -	2	33	GRAVEL, medium, gray; very dirty -	2	13
GRAVEL, fine to medium, red - - - -	8	41	GRAVEL, medium to coarse, green - -	1	14
CLAY, sandy, tan - - - - -	5	46	CHALK or lime, medium hard, white -	1	15
GRAVEL, medium to coarse, green - -	9	55	CLAY, sandy, yellowish green to green; streaks of hard lime, flinty concretions - - - - -	9	24
SANDSTONE, light green; clay and fine green sand - - - - -	5	60	CLAY, sandy, buff tan - - - - -	7	31
GRAVEL, fine to very coarse, green	9	69	CLAY, sandy, buff green - - - - -	4	35
ROCK, quartzitic, dark green - - -	0	69	GRAVEL, medium, green - - - - -	4	39
			SHAILE, orange yellow, and brownish green quartzite - - - - -	0	39
80. NW $\frac{1}{4}$ Sec. 8, T.3 N., R.28 W.; 0.2 mile south of north section line, 300 feet north of bridge, on west side of road. Ground elevation, 2,422 feet (t); depth to water, 7.8 feet, October 14, 1941.			84. NE $\frac{1}{4}$ Sec. 17, T.3 N., R.28 W.; 0.2 mile south of north section line, on east side of road. Ground elevation, 2,420 feet (t); depth to water, 28.7 feet, October 7, 1941.		
			ROAD FILL, gravelly, and dark brown sandy soil - - - - -	6	6
SOIL, sandy, black - - - - -	5	5	CLAY, sandy, buff - - - - -	8	14
SOIL, sandy, dark brown - - - - -	8	13	CLAY, sandy, tan; streaks of indur- ated clay - - - - -	3	17
SILT, very fine, and red sand - - -	8	21	SAND, fine, red - - - - -	2	19
CLAY, sandy, medium gray - - - -	12	33	CLAY, sandy, light green - - - - -	3	22
GRAVEL, fine to medium, red - - - -	17	50	CLAY, sandy, medium, grayish blue -	6	28
GRAVEL, fine to medium, red; harder, limy pieces - - - - -	10	60			
SHAILE, black; streaks of Bentonite	4	64			
GRAVEL, coarse, red - - - - -	2	66			
SHAILE, black - - - - -	3	69			
81. SE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 12, T.3 N., R.28 W.; 0.23 mile west of southeast corner of forty, on north side of road. Ground elevation, 2,400 feet (t); depth to water, 21.9 feet, September 15, 1941.					

	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
CLAY, sandy, dark gray to medium blue - - - - -	18	46	89. Northwest corner of NW $\frac{1}{4}$ Sec. 21, T.3 N., R. 28 W.; 100 feet north of river bridge, on west side of road. Ground elevation, 2,405 feet (t); depth to water, caved at 8.1 feet, October 7, 1941.		
GRAVEL, medium to coarse, green - -	22	68	SAND, very fine, red - - - - -	9	9
GRAVEL, medium to very coarse, red	4	72	SAND, medium, gray; streaks of very fine sand - - - - -	40	49
GRAVEL, fine, green - - - - -	2	74	SHAILE, hard, dark gray to black - -	3	52
SHAILE, speckled, buff to bluish gray	5	79			
85. SE $\frac{1}{4}$ Sec. 17, T.3 N., R.28 W.; 0.2 mile south of northwest corner of quarter, on east side of road. Ground elevation, 2,418 feet (t); depth to water, 12.5 feet, October 7, 1941.			90. Northwest corner of SW $\frac{1}{4}$ Sec. 21, T.3 N., R.28 W.; on east side of road. Ground elevation, 2,407 feet (t); depth to water, 6.6 feet, October 11, 1941.		
SOIL and roadfill, sandy, dark grayish brown - - - - -	7	7	ROAD FILL of gravel and buff sandy soil - - - - -	3	3
CLAY, very sandy, light buff - - -	11	18	SAND, very fine, and medium gravel, red - - - - -	6	9
SAND, fine to medium, red - - - -	24	42	GRAVEL, medium, gray; streaks of black sandy silt - - - - -	1	10
SAND, coarse, and fine green gravel	4	46	CLAY, sandy, light gray - - - - -	1	11
SHAILE, speckled, buff to dark olive drab - - - - -	3	49	SAND, fine, to medium gray gravel -	15	26
86. Southwest corner of SW $\frac{1}{4}$ Sec. 17, T.3 N., R.28 W.; 50 feet south of railroad, on east side of trail. Ground elevation, 2,424 feet (t); depth to water, 15.1 feet, October 27, 1941.			GRAVEL, coarse, gray - - - - -	9	35
TOP SOIL, sandy, dark brown - - - -	4	4	SAND, fine, red, to fine red gravel	30	65
SOIL, sandy, gray buff - - - - -	3	7	SHAILE, grayish buff to dark gray -	4	69
SILT, black to dark brown - - - - -	1	8	91. Northeast corner of SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 22, T.3 N., R.28 W.; 200 feet west of east line, on south side of road. Ground elevation, 2,410 feet (t); depth to water, 21.5 feet, October 11, 1941.		
CLAY, sandy, grayish buff - - - -	2	10	ROAD FILL and dark brown sandy soil	10	10
CLAY, sandy, grayish yellow - - - -	4	14	SOIL, silty, black - - - - -	4	14
CLAY, gray - - - - -	3	17	CLAY, sandy, tan to buff - - - - -	4	18
GRAVEL, medium to coarse, red - - -	4	21	CLAY, sandy, light buff gray - - -	7	25
SAND, fine, red - - - - -	1	22	SAND, very fine to medium, reddish gray - - - - -	3	28
CLAY, sandy, grayish yellow to yellow green - - - - -	6	28	LIME, very fine to medium; cemented gray sand, streaks of white limy clay, hard streaks throughout - -	16	44
SAND, fine, green, and medium green gravel - - - - -	7	35	FLINT or chert, very hard, greenish brown - - - - -	0	44
GRAVEL, medium to coarse, green - -	2	37	92. NE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 23, T.3 N., R.28 W.; 600 feet west of east section line, on south edge of road. Ground elevation, 2,390 feet (t); 19.9 feet, September 30, 1941.		
CLAY, indurated, yellowish green -	1	38	ROAD FILL and brown sandy soil - -	17	17
SHAILE, yellow to light gray - - - -	1	39	SILT, brown to gray; some lime fragments - - - - -	3	20
87. NE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 17, T.3 N., R.28 W.; 50 feet north of southeast corner of forty, on west side of road. Ground elevation, 2,410 feet (t); depth to water, caved at 8 feet, October 7, 1941.			SILT, sandy, light brown to buff -	19	39
ROAD FILL and buff sandy silt - - -	3	3	SANDSTONE, silty, soft pink to green	5	44
SAND, very fine, red - - - - -	12	15	CLAY, sandy, white to light pink gray; some gravel stones - - - -	6	50
SAND, fine to coarse, gray - - - -	12	27	GRAVEL, medium, green; clean - - -	3	53
SAND, very fine, reddish gray - - -	12	39	ROCK, quartzitic, hard, green - - -	0	53
SAND, very fine, to medium red gravel	24	63	93. Northeast corner of NE $\frac{1}{4}$ Sec. 28, T.3 N., R. 28 W.; 100 feet west of section corner, on south side of road. Ground elevation, 2,425 feet (t); depth to water, 30.6 feet, October 11, 1941.		
SHAILE, speckled, grayish buff to dark gray - - - - -	6	69	ROAD FILL and dark brown soil - - -	4	
88. SE $\frac{1}{4}$ Sec. 20, T.3 N., R.28 W.; 0.2 mile north of southeast corner of quarter, on west side of road. Ground elevation, 2,407 feet (t); depth to water, 6.2 feet, October 11, 1941.			CLAY, sandy, tan - - - - -	4	
ROAD FILL, black sandy soil - - - -	3	3			
SOIL, sandy, light tan - - - - -	3	6			
SAND, fine, red - - - - -	6	12			
GRAVEL, medium to very coarse, grayish green - - - - -	19	31			
SAND, fine, red, and medium to coarse red gravel - - - - -	22	53			
SHAILE, buff to dark gray - - - - -	6	59			

	Thick- ness (feet)	Depth (feet)
SILT, sandy, fine, brown - - - - -	2	10
CLAY, buff green - - - - -	11	21
SAND, very fine - - - - -	8	29
SAND, fine, and medium to coarse red gravel - - - - -	10	39
GRAVEL, medium to very coarse, red	5	44
SHALE, yellow to dark olive drab -	5	49

94. Southeast corner of NE $\frac{1}{4}$ Sec. 29, T.3 N., R. 28 W.; 120 feet north of half section line, on west side of road. Ground elevation, 2,444 feet (t); depth to water, 33.4 feet, October 11, 1941.

ROAD FILL and dark brown soil - - -	7	7
CLAY, silty, light tan to buff - -	26	33
GRAVEL, fine to medium, red - - -	6	39
CLAY, sandy, tan - - - - -	5	44
GRAVEL, fine to coarse, red - - -	18	62
CLAY, sandy, grayish yellow - - -	4	66
GRAVEL, very coarse, red - - -	3	69
CLAY, sandy, yellowish green - - -	7	76
CLAY, limy, whitish yellow; some hard streaks - - - - -	1	77
ROCK, cherty, hard, white - - - -	0	77

95. SE $\frac{1}{4}$ Sec. 22, T.1 N., R.28 W.; 50 feet east of southwest corner of quarter on north edge of road. Ground elevation, 2,491 feet (a); depth to water, 27.4 feet, August 28, 1941.

ROAD FILL and dark brown sandy soil	5	5
CLAY, silty, sandy, buff - - - - -	23	28
SAND, clayey, grayish buff - - - -	10	38
GRAVEL, fine to coarse, red; fairly compact - - - - -	12	50
BOULDERS or gravel, embedded in clay - - - - -	1	51
GRAVEL, fine, medium, coarse, com- pact, reddish - - - - -	9	60
SHALE, light gray to tan to rusty brown; tough, compact, sticky - -	8	68

96. SE $\frac{1}{4}$ Sec. 23, T.1 N., R.28 W.; 550 feet south of northeast corner of quarter, on west edge of road. Ground elevation, 2,477 feet (a); depth to water, 19.1 feet, August 28, 1941.

ROAD FILL and dark brown sandy clay	5	5
SAND, soft, clayey, buff - - - - -	15	20
SAND, clayey, buff to brown; small amount of gravel - - - - -	7	27
SAND, and fine gravel, very compact, gray - - - - -	3	30
GRAVEL, fine to coarse, reddish; slightly compact - - - - -	14	44
GRAVEL, fine, medium, coarse, reddish; some water-worn shale, fairly com- pact, good - - - - -	10	54
SHALE, plastic, tough, light gray -	1	55
SHALE, rusty colored to gray; very sticky, tough, plastic - - - - -	4	59

97. NE $\frac{1}{4}$ Sec. 26, T.1 N., R.28 W.; 0.25 mile south of northeast corner of section, 0.1 mile north of highway, 0.1 mile south of present channel of Beaver Creek, on west edge of road. Ground elevation, 2,467 feet (a); depth to water, 4.2 feet, August 28, 1941.

ROAD FILL and dark brown clayey soil - - - - -	5	5
SAND, clayey, soft, brown - - - - -	4	9
SAND, clayey, gray; some fine gra- vel, loose - - - - -	4	13
SAND and fine gravel, silty, gray -	5	18
GRAVEL, fine to coarse, loose; green- ish grayish red - - - - -	12	30
GRAVEL, fine to coarse, green, gray, red; good, more coarse than above	5	35
SHALE, hard, olive gray to dark gray, slight greenish cast - - - - -	4	39

98. SW $\frac{1}{4}$ Sec. 28, T.1 N., R.28 W.; 0.43 mile north of southwest corner of section, on east edge of road. Ground elevation, 2,530 feet (a); depth to water, 47.0 feet, August 28, 1941.

ROAD FILL - - - - -	5	5
SAND, silty, clayey, buff; loess-like	22	27
SAND, silty, clayey, dark buff; loess- like - - - - -	8	35
SAND, clayey, reddish buff - - - -	6	41
SAND, clayey, coarse, soft, grayish buff - - - - -	2	43
GRAVEL, fine to coarse, red; some- what compact, some black gravel -	12	55
GRAVEL, medium to coarse, some fine, red; good, some black gravel - -	5	60
SHALE, tough, plastic, sticky, tan to light gray - - - - -	5	65

99. SE $\frac{1}{4}$ Sec. 28, T.1 N., R.28 W.; 0.38 mile north of southeast corner of section, on west edge of road. Ground elevation, 2,477 feet (a); depth to water, 12.5 feet, August 28, 1941.

ROAD FILL - - - - -	4	4
SAND, fine, clayey, brownish buff -	5	9
SAND, soft, clayey, dark brownish gray - - - - -	5	14
GRAVEL, fine to medium, reddish, loose; much sand - - - - -	4	18
CLAY, silty, gray - - - - -	2	20
GRAVEL, fine to coarse, good, gray- ish red - - - - -	7	27
SILT, dark gray - - - - -	2	29
GRAVEL, fine to coarse, reddish gray; good - - - - -	6	37
GRAVEL, fine to coarse, compact, reddish brown - - - - -	2	39
SHALE, light gray, rusty streaks giving part of shale a tan color; tough, plastic, sticky - - - - -	9	48

RED WILLOW COUNTY

	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
100. SW $\frac{1}{4}$ Sec. 31, T.1 N., R.28 W.; 60 feet north of southwest corner of section, on east edge of road. Ground elevation, 2,518 feet (a); depth to water, 6.5 feet, August 28, 1941.			CLAY, sandy, tan - - - - -	7	7
ROAD FILL and dark brown sandy soil to brown buff sandy clay - - - - -	9	9	SOIL, sandy, black to gray - - - - -	4	11
SAND, clayey, soft, buff - - - - -	5	14	CLAY, sandy, bluish gray - - - - -	8	19
SAND, and fine gravel; very poor sample - - - - -	2	16	GRAVEL, medium to very coarse, red; hard streak at 41 feet - - - - -	30	49
GRAVEL, fine to coarse, loose, reddish - - - - -	4	20	SAND, very fine, red - - - - -	19	68
GRAVEL, medium to coarse, reddish, some green - - - - -	5	25	GRAVEL, fine to medium, green - - - - -	37	105
GRAVEL, coarse, very loose, greenish, some red - - - - -	5	30	SAND, very fine, green; some medium gravel - - - - -	12	117
GRAVEL, coarse, greenish and red; slightly finer than above, loose, good - - - - -	4	34	SHALE, grayish yellow to black - - - - -	2	119
SHALE, tough, compact, dark lead gray - - - - -	4	38	104. NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 22, T.4 N., R.29 W.; on east center line of forty, 0.15 mile south of north line of section, on east side of road. Ground elevation, 2,480 feet (a); depth to water, 21.4 feet, October 16, 1941.		
101. NW $\frac{1}{4}$ Sec. 32, T.1 N., R.28 W.; 0.35 mile south of northwest corner of section, just south of where creek used to cross road, on east edge of road. Ground elevation, 2,504 feet (a); depth to water, 6.9 feet, August 28, 1941.			ROAD FILL and brown sandy soil - - - - -	6	6
ROAD FILL, dark brown sandy soil - - - - -	4	4	SOIL, sandy, black - - - - -	6	12
SAND, clayey, light brown - - - - -	4	8	CLAY, sandy, buff gray - - - - -	8	20
SAND, clayey, grayish brown; somewhat granular, sticky - - - - -	6	14	CLAY, sandy, grayish blue; limy streaks - - - - -	23	43
SILT, sand; poor sample - - - - -	4	18	GRAVEL, fine to medium, red - - - - -	2	45
GRAVEL, fine to medium, some coarse, reddish; fair - - - - -	9	27	CLAY, sandy, bluish green - - - - -	7	52
SHALE, light gray, rusty streaks, upper part has tan color; very tough, plastic, sticky - - - - -	9	36	GRAVEL, fine to coarse, red; hard streak at 63 feet - - - - -	22	74
102. NE $\frac{1}{4}$ Sec. 33, T.1 N., R.28 W.; 0.1 mile south of railroad at Marion depot, 180 feet north of road intersection. Ground elevation, 2,507 feet (a); depth to water, 28.8 feet, August 28, 1941.			GRAVEL, medium, compact, green - - - - -	7	81
ROAD FILL and dark brown sandy soil - - - - -	5	5	SHALE, yellowish gray to gray - - - - -	8	89
CLAY, silty, sandy, soft, buff; loess-like - - - - -	13	18	105. Southwest corner of SW $\frac{1}{4}$ Sec. 25, T.4 N., R.29 W.; 50 feet east of southwest corner of section, on north side of road. Ground elevation, 2,490 feet (a); depth to water, 37.8 feet, October 14, 1941.		
SAND, clayey, soft, brown - - - - -	5	23	ROAD FILL and black sandy soil - - - - -	6	6
CLAY, sandy, dark brown; old soil - - - - -	2	25	CLAY, sandy, tan to buff - - - - -	45	51
CLAY, sandy, compact, grayish buff - - - - -	5	30	CLAY, sandy, grayish blue - - - - -	7	58
SAND and fine gravel; poor sample - - - - -	2	32	CLAY, sandy, dark blue to black - - - - -	21	79
GRAVEL, fine to coarse, red; good - - - - -	13	45	GRAVEL, fine to coarse, red - - - - -	12	91
GRAVEL, fine to coarse, red; good, thin clay seam at 45 feet - - - - -	5	50	SHALE, grayish yellow to medium gray - - - - -	8	99
SHALE, light bluish gray, rusty streaks give tan color; tough, plastic - - - - -	5	55	106. Southwest corner of SW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 25, T.4 N., R.29 W.; about 600 feet west of bridge, on north side of road. Ground elevation, 2,452 feet (a); depth to water, 6.8 feet, October 14, 1941.		
SHALE, dark bluish gray; tough, plastic, sticky - - - - -	4	59	SOIL, sandy, brown - - - - -	7	7
103. SE $\frac{1}{4}$ NW $\frac{1}{4}$ of Sec. 6, T.4 N., R.29 W.; approximately in the center of south edge of forty, 100 feet east of highway and north of creek, 100 feet south of old bridge. Ground elevation, 2,519 feet (a); depth to water, 12.4 feet, October 16, 1941.			SOIL, sandy, bluish gray - - - - -	1	8
			SAND, fine to coarse, gray; streaks of gray clay - - - - -	20	28
			GRAVEL, fine to coarse, red - - - - -	12	40
			SAND, limy, cemented, grayish buff - - - - -	6	46
			GRAVEL, medium to coarse, red - - - - -	9	55
			SHALE, yellow - - - - -	3	58
			SHALE, black - - - - -	1	59
			107. Southwest corner of SE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 25, T.3 N., R.29 W.; on north side of road. Ground elevation, 2,436 feet (t); depth to water, 7.5 feet, October 25, 1941.		
			SOIL, sandy, dark brown - - - - -	4	4
			CLAY, sandy, tan - - - - -	3	7
			GRAVEL, fine to medium, red - - - - -	5	12
			GRAVEL, fine to medium, gray - - - - -	5	17

	Thick- ness (feet)	Depth (feet)
GRAVEL, coarse to very coarse, gray	16	33
SAND, fine to medium, gray	3	36
GRAVEL, coarse to very coarse, gray	7	43
SHALE, very hard, black	0	43

108. Southwest corner of SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 25, T.3 N., R.29 W.; 0.2 mile west of southeast corner of section, on north side of road. Ground elevation, 2,439 feet (t); depth to water, 13.2 feet, October 27, 1941.

ROAD FILL and grayish buff sandy clay	4	4
SOIL, sandy, dark brown	3	7
CLAY, sandy, grayish tan	2	9
SAND, medium, red, and fine to medium red gravel	6	15
GRAVEL, medium to coarse, red	3	18
GRAVEL, medium to coarse, gray	1	19
GRAVEL, coarse to very coarse, red	3	22
GRAVEL, medium to coarse, red	3	25
SAND, medium, red, and fine red gravel	6	31
SAND, fine, red	4	35
GRAVEL, medium to coarse, red; dirty	1	36
SHALE, black	3	39

109. NW $\frac{1}{4}$ Sec. 28, T.29 W., R.3 N.; just north of bridge across drainage line, about $\frac{1}{4}$ mile north of pavement, on east side of road. Ground elevation, 2,482 feet (t); depth to water, not measured, July 3, 1935.

ALLUVIUM	15	15
CLAY; fine gravel, reworked	4	19
SAND, coarse, and fine gravel	4	23
CLAY, sandy, yellow	16	39
SHALE (Pierre)	4	43

110. SE $\frac{1}{4}$ Sec. 28, T.3 N., R.29 W.; 40 feet west of southeast corner of section, on north side of road. Ground elevation, 2,482 feet (t); depth to water, 34.3 feet, October 20, 1941.

CLAY, sandy, tan	40	40
CLAY, very sandy, bluish gray	9	49
GRAVEL, fine to medium, gray	7	56
SHALE, black	3	59

111. Northwest corner of NW $\frac{1}{4}$ Sec. 32, T.3 N., R.29 W.; 30 feet east of west section line, on south side of trail. Ground elevation, 2,468 feet (t); depth to water, 2.8 feet, October 25, 1941.

SOIL, sandy, gray	3	3
SAND, fine to medium, red	4	7
GRAVEL, fine to medium, gray; clean	4	11
GRAVEL, medium to coarse, gray; clean	10	21
SHALE, medium, gray	4	25

112. Southeast corner of NW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 32, T.3 N., R.29 W.; 0.2 mile south of north line, 50 feet west of highway, 200 feet north of river bridge. Ground elevation, 2,466 feet (t); depth to water, 25.4 feet, October 20, 1941.

	Thick- ness (feet)	Depth (feet)
CLAY, sandy, tan	30	30
CLAY, sandy, grayish blue	6	36
GRAVEL, fine to coarse, green; seams of very fine sand	5	41
SHALE, dark gray; very hard at 43 feet	2	43

113. Northwest corner of NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 33, T.3 N., R.29 W.; on south side of road. Ground elevation, 2,488 feet (t); depth to water, 28.9 feet, October 25, 1941.

ROAD FILL and dark brown sandy soil	2	2
CLAY, sandy, tan	30	32
CLAY, sandy, grayish blue	12	44
GRAVEL, medium, gray; dirty	2	46
GRAVEL, medium, gray; much reworked shale and blue clay	1	47
SHALE, black	2	49

114. NE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 33, T.3 N., R.29 W.; 60 feet west of southeast corner of forty, at west end of curve, on north edge of road. Ground elevation, 2,454 feet (t); depth to water, 4.5 feet, October 25, 1941.

ROAD FILL	4	4
CLAY, sandy, gray	3	7
SAND, fine, gray	3	10
SAND, and fine gravel, grayish green	11	21
SAND, fine to coarse, red	9	30
SAND and fine gravel, red	11	41
GRAVEL, fine, some coarser	4	45
GRAVEL, fine, some coarser, red; some water-worn shale	20	65
GRAVEL, fine to coarse, red; some water-worn shale, good	8	73
SHALE, dark gray to black	6	79

115. Northwest corner of SE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 33, T.3 N., R.29 W.; on south side of road. Ground elevation, 2,464 feet (t); depth to water, 6.8 feet, October 25, 1941.

ROAD FILL and brown sandy soil	4	4
CLAY, sandy, tan	6	10
CLAY, sandy, bluish gray	4	14
GRAVEL, medium to coarse, gray	12	26
GRAVEL, coarse to very coarse, gray	4	30
SAND, fine, gray	4	34
GRAVEL, coarse to very coarse, gray	7	41
SHALE, black	3	44

116. NW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 35, T.3 N., R.29 W.; 0.1 mile north of northwest corner of forty, on east side of road. Ground elevation, 2,453 feet (t); depth to water, 9.1 feet, October 25, 1941.

SOIL, sandy, dark brown	4	4
CLAY, sandy, tan	3	7
CLAY, sandy, grayish buff	4	11
GRAVEL, medium, red; some gray clay streaks	3	14
GRAVEL, medium to coarse, red	4	18
GRAVEL, fine to medium, red	3	21
SAND, fine, red	3	24

	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
GRAVEL, coarse, red - - - - -	4	28	121. Northwest corner of SW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 3, T.2 N., R.29 W.; 100 feet south of quarter line, on east side of road. Ground elevation, 2,483 feet (t); depth to water, 25 feet, October 25, 1941.		
GRAVEL, fine to medium, red - - - - -	9	37			
SAND, fine, red - - - - -	9	46	SOIL, sandy, dark brown - - - - -	8	8
SAND, fine, red - - - - -	9	46	CLAY, sandy, buff tan - - - - -	15	23
GRAVEL, fine to medium, red - - - - -	6	52	SILT, dark brown - - - - -	4	27
SAND, very fine, red - - - - -	4	56	CLAY, sandy, tan - - - - -	4	31
GRAVEL, medium, red - - - - -	12	68	SILT, sandy, grayish tan - - - - -	6	37
SHALE, black - - - - -	1	69	SAND, very fine, to medium gravel, red - - - - -	19	56
117. NW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 36, T.3 N., R.29 W.; 200 feet east of west section line, on north side of road. Ground elevation, 2,480 feet (t); depth to water, 31.5 feet, October 25, 1941.			SHALE, speckled, light gray - - - - -	2	58
SOIL, sandy, dark brown - - - - -	3	3	SHALE, black - - - - -	1	59
SAND, very fine, red; dirty - - - - -	8	11	122. Southeast corner of NW $\frac{1}{4}$ Sec. 5, T.2 N., R.29 W.; 50 feet west of center of section, on north side of road. Ground elevation, 2,486 feet (t); depth to water, 19.4 feet, October 20, 1941.		
CLAY, sandy, buff gray - - - - -	19	30	CLAY, sandy, tan to brown - - - - -	20	20
CLAY, sandy, reddish buff to grayish buff - - - - -	4	34	GRAVEL, medium, red; dirty - - - - -	11	31
GRAVEL, coarse, red; some pink lime and dark clay, dirty - - - - -	2	36	GRAVEL, medium, gray - - - - -	12	43
SHALE, black, some yellow streaks at top - - - - -	3	39	GRAVEL, fine to medium, red; clean - - - - -	16	59
118. Northeast corner of NE $\frac{1}{4}$ Sec. 3, T.2 N., R.29 W.; 25 feet west of east section line, 10 feet south of north section line, on south side of road. Ground elevation, 2,459 feet (t); depth to water, 13 feet, October 25, 1941.			SAND, very fine to coarse, red - - - - -	27	86
ROAD FILL and black sandy soil - - - - -	8	8	SHALE, dark gray - - - - -	3	89
CLAY, sandy, tan - - - - -	12	20	123. Northeast corner of SE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 8, T.2 N., R.29 W.; 50 feet west of highway, 30 feet north of irrigation ditch. Ground elevation, 2,518 feet (t); depth to water, caved at 52.5 feet, October 20, 1941.		
GRAVEL, medium to very coarse, gray - - - - -	9	29	SOIL, sandy, dark grayish brown - - - - -	5	5
GRAVEL, coarse, red - - - - -	2	31	CLAY, sandy, tan - - - - -	36	41
GRAVEL, very fine to very coarse, red - - - - -	28	59	CLAY, sandy, dark gray - - - - -	4	45
SHALE, black - - - - -	4	63	CLAY, sandy, tan - - - - -	13	52
119. Northeast corner of NW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 3, T.2 N., R.29 W.; on south side of road. Ground elevation, 2,462 feet (t); depth to water, 12.3 feet, October 20, 1941.			GRAVEL, fine to medium, red - - - - -	24	76
SOIL, sandy, dark brown - - - - -	10	10	SHALE, dark gray - - - - -	3	79
CLAY, sandy, buff tan - - - - -	5	15	124. SW $\frac{1}{4}$ Sec. 18, T.1 N., R.29 W.; 225 feet east of southwest corner of section, on north edge of road. Ground elevation, 2,805 feet (a); depth to water, 127 feet, September 23, 1941.		
SAND, very fine, to medium gravel, gray - - - - -	15	30	SILT, buff; gastropod shells (Peorian) - - - - -	15	15
GRAVEL, medium to coarse, gray - - - - -	10	40	SILT, buff; slightly harder than above (Peorian) - - - - -	18	33
SAND, medium to coarse, gray - - - - -	12	52	SILT, sandy, reddish brown; limy concretions after 38 feet (Loveland) - - - - -	12	45
SAND, very fine, red, to medium gravel - - - - -	29	81	SAND, silty, limy, whitish brown - - - - -	7	52
SHALE, dark gray to black - - - - -	3	84	SAND, silty, reddish brown - - - - -	16	68
120. Southeast corner of SW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 3, T.2 N., R.29 W.; 200 feet west of quarter line, on north side of road. Ground elevation, 2,495 feet (t); depth to water, 38.7 feet, October 25, 1941.			SAND, silty, clayey, reddish; some lime - - - - -	3	71
ROAD FILL and black sandy soil - - - - -	6	6	SILT and sand, limy, whitish - - - - -	7	78
CLAY, sandy, tan to grayish buff - - - - -	44	50	SAND, clayey, coarse, red - - - - -	2	80
GRAVEL, fine to medium, red - - - - -	4	54	GRAVEL, fine to medium, red - - - - -	9	89
SHALE, black - - - - -	5	59	SANDSTONE, hard, reddish, brown; limy streaks, reddish sand settles in mud ditch - - - - -	13	102

1240

127 SWL

	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
SAND, clayey, reddish - - - - -	3	105	SAND, silty, light greenish gray; some gravel - - - - -	4	40
SANDSTONE, brittle, reddish brown to slightly gray - - - - -	7	112	GRAVEL, fine to coarse, red; poor -	3	43
CLAY, fine, indurated, grayish green; cuts small chips - - - - -	3	115	SHALE, light grayish tan, rusty colored streaks; tough, plastic, sticky - - - - -	6	49
CLAY, indurated, or siltstone, hard, light brown - - - - -	6	121			
SAND, clayey, brownish green - - -	4	125	126. SE $\frac{1}{4}$ Sec. 13, T.4 N., R.30 W.; 0.3 mile west of southeast corner of section, on north edge of road. Ground elevation, 2,750 feet (a); depth to water, caved at 198.5 feet, September 23, 1941.		
SANDSTONE, fairly hard, dark reddish brown - - - - -	6	8100 133			
GRAVEL, fine, reddish - - - - -	1	134			
SANDSTONE, clayey, soft, brownish tan - - - - -	4	138	ROAD FILL - - - - -	5	5
CLAY, sand and fine gravel, soft -	7	145	SILT, soft, buff (Peorian) - - - -	37	42
GRAVEL, fine to medium, loose, clear reddish - - - - -	5	150	SILT, reddish buff, to sandy clay (Loveland) - - - - -	21	63
SANDSTONE, hard, compact, reddish brown - - - - -	4	154	SILT, limy, light buff to whitish -	3	66
SANDSTONE, limy, whitish buff - - -	8	162	CLAY, silty, reddish buff - - - - -	9	75
LIMESTONE, impure, grayish tan; shines when wet, very hard, had to force pipe - - - - -	6	168	SILT, clayey, limy, whitish buff -	36	111
CLAY, sandy, soft, grayish brown -	7	175	SANDSTONE, fine, light gray; limy in spots, brown pebbly sandstone texturally similar, more limy sandstone below - - - - -	8	119
CLAY, sticky, greenish gray; some hard clay particles - - - - -	10	185	CLAY, firm, semi-indurated, mottled, light green and reddish brown, pale green near bottom; hard from 122 to 123 feet, light green and brown below 123 feet - - - - -	16	135
CLAY, sandy, hard, dark brown, cho- colate colored; chips like sand- stone - - - - -	8	193	SILTSTONE or sandstone, fine, hard, limy, white; probably contains light green and brown indurated clay, light green and brown fine sandstone, more limy material - -	7	142
CLAY, sandy, greenish gray; hard, cuts like sandstone - - - - -	4	197	SILT, sandy, clayey, limy, pale greenish; harder zone from 145 to 147 feet - - - - -	5	147
SAND, clayey, soft, light reddish tan and greenish gray - - - - -	4	201	SANDSTONE, fine, brown; perhaps also limy gray material of similar tex- ture - - - - -	6	153
SILT, clayey, light green - - - - -	14	215	SILT, sandy, clayey, soft, light gray, getting reddish with depth - - -	3	156
CLAY, firm, pink and pale green mottled - - - - -	7	222	SANDSTONE, fine, impure, limy, limy gray, may be brown at top; silt and some clay, thin seam of firmer brown sandstone at 169 feet - - - - -	28	72150 228
CLAY, light gray, greenish tinge, and sandy clay - - - - -	4	226	GRAVEL, medium, green, some red par- ticles; some quartz, angular grains, poorly sorted, some fine material, cemented with lime, light green clean medium soft cemented sandstone -	10	238
CLAY, grayish brown; soft sandy clay, contains harder concretions	7	233	SANDSTONE, some gravel, medium, slight- ly cemented, light green - - - -	9	247
CLAY, compact, reddish brown to pink; firm and hard - - - - -	4	237	SILT, sandy, clayey, light green -	1	248
GRAVEL, medium, poorly sorted, angu- lar grains; probably contains thin band of clay - - - - -	8	245	CLAY, sandy, limy white, or clayey silt; grayer at 250 feet - - - -	4	252
CLAY, soft, light brown; sticky, gritty - - - - -	9	254	SILT, soft, sandy, light grayish green; probably clay, very soft from 254 to 257 feet - - - - -	2	254
CLAY, compact, consolidated, hard, light brown and green - - - - -	2	256	SANDSTONE, fine, light gray and green; probably some silt zones - - - -	3	257
GRAVEL; associated with light gray- ish brown silty and sandy clay -	5	261	CLAY, limy white with greenish cast; some indurated, contains sand grains	3	260
GRAVEL, medium, poorly sorted, angu- lar grains, red grains abundant -	4	265	SANDSTONE, coarse, grayish brown; con- tains silt - - - - -	8	268
SHALE, buff and drab to medium gray; white Bentonite at about 275 feet (Niobrara, Pierre?) - - - - -	15	280	GRAVEL, medium, green and pink - -	3	271
125. NE $\frac{1}{4}$ Sec. 36, T.1 N., R.29 W.; 0.2 mile south of northeast corner of section, on west edge of road. Ground elevation, 2,530 feet (a); depth to water, 25.7 feet, August 28, 1941.					
ROAD FILL and dark brown loamy sand	9	9			
CLAY, silty, sandy, buff; loess-like, contains shells - - - - -	21	30			
SAND, soft, silty, clayey, buff; loess-like, contains shells - - -	6	36			

2800
1400

10,000

2700

450

3200

44,000
64,550

RED WILLOW COUNTY

21

	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
SILT, sandy, light gray, or very fine silty sand; hard white lime and grains of gravel and coarse sand - - - - -	8	279	GRAVEL, medium, well sorted; quartz, more red chert grains, some green grains - - - - -	28	146 336.
GRAVEL, fine to medium, green, pink and white; light green silt, clay, coarse sand and gravel mixture from 289 to 297 feet, more gravel and very little clay below 297 feet, coarse gravel near bottom - - - -	37	316	SILT, sandy, soft, light gray, slight greenish cast - - - - -	5	151
SHALE, gray, white, olive and rusty red (Pierre) - - - - -	4	320	CLAY, sandy, green drab - - - - -	4	155
127. SW $\frac{1}{4}$ Sec. 7, T.3 N., R.30 W.; 150 feet north of southwest corner of section, on east edge of road. Ground elevation, 2,570 feet (a); depth to water, 26.4 feet, November 1, 1941.			GRAVEL, fine, red - - - - -	10	165 100.
ROAD FILL and brown sandy soil - - -	4	4	GRAVEL, medium, chiefly green - - -	6	171
SAND, silty, clayey, buff; darker brown from 20 feet - - - - -	21	25	CLAY, hard, tan; flinty appearance, almost conchoidal fracture - - -	1	172
GRAVEL, fine to medium, red - - - -	2	27	GRAVEL, medium; quartz, red and green grains - - - - -	10	182 120
GRAVEL, fine to coarse, compact, red, some green; much lime and brown sandstone pebbles - - - - -	7	34	SHALE, weathered, tan - - - - -	4	186
GRAVEL, fine to coarse, red, some green; slightly compact, clean, some lime pebbles - - - - -	7	41	SHALE, dark slate gray, slight blue color (Pierre) - - - - -	14	200
GRAVEL, fine to medium, clean, red	5	46	129. SE $\frac{1}{4}$ Sec. 18, T.3 N., R.30 W.; 0.2 mile north of southeast corner of section, on west edge of road. Ground elevation, 2,549 feet (t); depth to water, 19.1 feet, November 1, 1941.		
GRAVEL, medium to coarse, red; clean some very coarse - - - - -	11	57	ROAD FILL and brown silty sand - - -	8	8
GRAVEL, fine to medium, red, some green - - - - -	7	64	SAND, silty, buff to brown - - - -	6	14
CLAY, very sandy, tan - - - - -	3	67	SAND and fine to medium red gravel	2	16
GRAVEL, fine to coarse, red and green; some green flint chips - - - - -	9	76	SAND and fine to medium red gravel; some dirty streaks - - - - -	10	26
SHALE, weathered, very light gray; may be slightly sandy clay - - -	4	80	GRAVEL, fine to coarse; fairly clean and loose - - - - -	5	31
SHALE, tough, rubbery, dark blue gray to black - - - - -	3	83	SAND and fine to medium gravel, loose, red; clean, some coarse gravel, good	13	44
128. SE $\frac{1}{4}$ Sec. 12, T.3 N., R.30 W.; 150 feet west of southeast corner of section, on north edge of road. Ground elevation, 2,630 feet (a); depth to water, caved at 97.5 feet, September 23, 1941.			GRAVEL, fine to coarse, red; some sand, fairly compact, good - - -	7	51
SILT, soft, buff (Peorian) - - - - -	24	24	SHALE, dark bluish gray; tough, compact - - - - -	8	59
SILT, sandy, buff (Peorian) - - - -	15	39	130. Southwest corner of Sec. 18, T.3 N., R.30 W.; 130 feet north of railroad, south of highway, on east side of trail. Ground elevation, 2,538 feet (t); depth to water, 3.6 feet, November 1, 1941.		
SILT, clayey, reddish buff, brown (Loveland) - - - - -	5	44	TOP SOIL, gray, and grayish buff sandy clay - - - - -	4	4
SILT, clayey, reddish buff - - - - -	4	48	SAND, fine to medium; some coarse greenish gray gravel - - - - -	8	12
SILT, sandy, limy whitish reddish; plastic, limy concretions - - - -	6	54	GRAVEL, medium to coarse, red; clay streak at 15 feet - - - - -	6	18
CLAY, tough, plastic, pinkish tan -	9	63	SAND, medium, red, to fine red gravel	8	26
CLAY, tan; hard tan clay and limy concretions - - - - -	9	72	GRAVEL, medium to coarse, red - - -	4	30
CLAY, tough, sticky, plastic, pinkish tan - - - - -	5	77	SAND, fine to medium, red; some fine red gravel - - - - -	8	38
SAND, soft, silty, tannish brown -	4	81	GRAVEL, fine to medium, red - - - -	3	41
CLAY, tough, plastic, light tannish brown - - - - -	5	86	SAND, fine, and fine red gravel - -	4	45
CLAY, sandy, limy, soft, whitish gray	3	89	GRAVEL, medium to coarse, red - - -	7	52
CLAY, less limy and softer - - - -	3	92	SHALE, dark bluish gray - - - - -	7	59
SILT, sandy, soft, tan - - - - -	12	104	131. NE $\frac{1}{4}$ Sec. 20, T.3 N., R.30 W.; 90 feet south of northeast corner of section, on west edge of road. Ground elevation, 2,536 feet (t); depth to water, 14.8 feet, November 1, 1941.		
SILT, sandy, soft, limy, whitish brown; some limy concretions - - - - -	8	112	ROAD FILL - - - - -	4	4
SILT, sandy, soft, clayey, tan; cuts in large pieces, some scattered gravel - - - - -	6	118	SAND, silty, buff - - - - -	3	7
			SAND, silty, light gray - - - - -	1	8
			GRAVEL, fine, red; dirty - - - - -	2	10
			GRAVEL, fine to medium; some sand, red - - - - -	7	17
			GRAVEL, some fine, mostly very coarse, red; some shale pebbles - - - -	4	21

	Thick- ness (feet)	Depth (feet)
GRAVEL, fine to medium, red; many shale pebbles - - - - -	3	24
GRAVEL, fine to medium, red; very clean - - - - -	2	26
GRAVEL, fine to very coarse, red; clean except first foot which has some black - - - - -	7	33
SHALE, dark bluish gray; compact, very little weathered at top - -	6	39

132. SE $\frac{1}{4}$ Sec. 20, T.3 N., R.30 W.; 0.15 mile south of railroad, on west edge of road. Ground elevation, 2,520 feet (t); depth to water, caved at 6 feet, November 1, 1941.

ROAD FILL and gray buff sandy clay	7	7
GRAVEL, medium to coarse, green - -	4	11
GRAVEL, fine to medium, some coarse, red - - - - -	4	15
GRAVEL, medium to coarse, red - - -	6	21
GRAVEL, medium dark, red - - - - -	4	25
GRAVEL, coarse, dark red - - - - -	6	31
GRAVEL, fine to medium, red - - - -	5	36
GRAVEL, coarse, red; some reworked shale pebbles - - - - -	5	41
GRAVEL, medium to coarse, red; some shale pebbles - - - - -	5	46
SHALE, dark gray - - - - -	3	49

133. SW $\frac{1}{4}$ Sec. 22, T.3 N., R.30 W.; 0.4 mile north of southwest corner, on east edge of road. Ground elevation, 2,515 feet (t); depth to water, caved at 11.9 feet, November 1, 1941.

ROAD FILL, dark brown sandy soil -	6	6
GRAVEL, medium, red; dirty, clay streak at 10 feet - - - - -	4	10
GRAVEL, medium to coarse, red - - -	5	15
SHALE, weathered, grayish yellow -	5	20
SHALE, dark gray - - - - -	9	29

134. SW $\frac{1}{4}$ Sec. 25, T.3 N., R.30 W.; 0.4 mile from west section line, just south of railroad, on north side of road. Ground elevation, 2,490 feet (t); depth to water, not measured, July 7, 1935.

ROAD FILL - - - - -	2	2
SOIL; embedded gravel, reworked material - - - - -	8	10
GRAVEL, fine - - - - -	2	12
SHALE (Pierre) - - - - -	3	15

135. SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 25, T.3 N., R.30 W.; 150 feet south of intersection, on west side of road. Ground elevation, 2,485 feet (t); depth to water, 8.8 feet, October 20, 1941.

GRAVEL, road fill, and tan sandy clay - - - - -	8	8
SAND, very fine, red - - - - -	2	10
SAND, fine to coarse, red - - - - -	14	24
SHALE, dark gray - - - - -	5	29

136. SW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 26, T.3 N., R.30 W.; 0.45 mile west of southeast corner, 40 feet north of highway, in ditch, 150 feet west of culvert, 600 feet southwest of old dry gravel pit. Ground elevation, 2,515 feet (t); depth to water, 20.2 feet, November 1, 1941.

SOIL, sandy, dark brown - - - - -	4	4
SAND, silty, brown to buff - - - -	3	7
SAND and fine to medium gravel, red, green; much lime, dirty - - - -	4	11
SAND, silty to clayey, brown - - -	4	15
SAND, silty to clayey, buff; some scattered gravel - - - - -	5	20
SANDSTONE, brown - - - - -	5	25
SHALE, dark bluish gray to black; tough, compact, rubbery - - - - -	4	29

137. NW $\frac{1}{4}$ Sec. 26, T.3 N., R.30 W.; just south of railroad, just east of section line, on south side of road. Ground elevation, 2,508 feet (t); depth to water, not measured, July 5, 1935.

ROAD FILL - - - - -	3	3
SOIL - - - - -	2	5
CLAY, yellow - - - - -	4	9
CLAY, silty, grayish - - - - -	1	10
SAND - - - - -	3	13
GRAVEL, fine - - - - -	3	16
GRAVEL, fairly coarse - - - - -	5	21
ROCK, conglomerate; unable to penetrate - - - - -	1	22

138. NW $\frac{1}{4}$ Sec. 26, T.3 N., R.30 W.; just south of railroad, 30 feet east of section line, on south side of road. Ground elevation, 2,508 feet (t); depth to water, not measured, July 6, 1935.

ROAD FILL - - - - -	3	3
LOAM, black - - - - -	2	5
LOESS, yellow - - - - -	5	10
CLAY, silty, fine - - - - -	1	11
GRAVEL, fine - - - - -	5	16
GRAVEL, fine, medium, coarse - - -	3	19
GRAVEL, fairly coarse; much water-worn Pierre, particularly from 19 to 22 feet and from 32 to 38 feet	19	38
SHALE (Pierre) - - - - -	5	43

139. SW $\frac{1}{4}$ Sec. 28, T.3 N., R.30 W.; 0.4 mile north of southwest corner of section, 0.18 mile south of river bridge, on east side of road. Ground elevation, 2,515 feet (t); depth to water, 11.15, November 1, 1941.

ROAD FILL and buff silty sand - - -	3	3
SAND, silty, brownish buff - - - -	7	10
GRAVEL, fine to medium; some fine sand, red - - - - -	6	16
GRAVEL, greenish gray and red - - -	1	17
SILT, gray - - - - -	1	18
GRAVEL, fine to medium, red; dirty	6	24
SILT, gray - - - - -	2	26

	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
GRAVEL, fine to medium, grayish red	3	29	SOIL, sandy, black	4	4
GRAVEL, fine to very coarse, greenish red; some large greenish gray rounded clay pebbles	13	42	CLAY, sandy, buff yellow	8	12
SHALE, hard, dark gray, slight greenish cast	5	47	SAND, fine to coarse, gray	9	21
			SAND, very fine to coarse, red; some compact streaks	38	59
140. NE $\frac{1}{4}$ Sec. 34, T.3 N., R.30 W.; 240 feet north of southeast corner, on west edge of road. Ground elevation, 2,496 feet (t); depth to water, 5.9 feet, November 1, 1941.			GRAVEL, fine to medium, red	3	62
ROAD FILL, very fine red sand	3	3	SAND, very fine, red	9	71
SOIL, sandy, dark brown, light at base	3	6	SHALE, dark gray	8	79
GRAVEL, medium to coarse, red	6	12			
GRAVEL, medium to very coarse, gray	16	28	144. SE $\frac{1}{4}$ Sec. 1, T.2 N., R.30 W.; 120 feet south of northeast corner of forty, on west side of road. Ground elevation, 2,500 feet (t); depth to water, 25.9 feet, October 20, 1941.		
GRAVEL, coarse to very coarse, red	1	29	SOIL, sandy, dark brown	10	10
GRAVEL, medium, greenish red; streaks of fine sand	37	66	CLAY, sandy, buff tan	11	21
SHALE, dark gray	3	69	SAND, very fine to coarse, red; very fine to medium sand predominating	51	72
			SHALE, dark gray	7	79
141. Southeast corner of SW $\frac{1}{4}$ Sec. 35, T.3 N., R.30 W.; 40 feet west of south center line, on north side of road. Ground elevation, 2,500 feet (t); depth to water, 18.2 feet, November 1, 1941.					
ROAD FILL, dark brown sandy soil	3	3	145. Northeast corner of SW $\frac{1}{4}$ Sec. 11, T.2 N., R.30 W.; 15 feet south of half section line, on west side of road. Ground elevation, 2,523 feet (t); depth to water, 20 feet, October 27, 1941.		
SOIL, sandy, medium brown	2	5	SOIL, sandy, dark brown to black	3	3
SAND, fine, red	6	11	CLAY, sandy, tannish yellow	34	37
GRAVEL, medium, red	6	17	CLAY, sandy, grayish tan	15	42
GRAVEL, coarse to very coarse, red	4	21	CLAY, sandy, blue	6	48
SAND, medium, red, and fine red gravel	3	24	GRAVEL, medium, gray; very dirty, much blue clay	6	54
GRAVEL, medium to coarse, red	5	29	GRAVEL, medium to coarse, green	3	57
GRAVEL, fine to coarse, red	13	42	GRAVEL, medium to very coarse, green; dirty, some gray clay and reworked shale	3	60
GRAVEL, fine, red; very compact, some reworked shale, slightly dirty	3	45	SHALE, sandy, light grayish blue	4	64
GRAVEL, medium to coarse, red; some reworked shale	6	51	GRAVEL, medium to coarse, green; clean	1	65
SAND, fine to medium, red	5	56	SHALE, black	4	69
GRAVEL, coarse to very coarse, green and red	14	70			
SHALE, dark gray	5	75	146. Northeast corner of SE $\frac{1}{4}$ Sec. 12, T.2 N., R.30 W.; 50 feet south of half section line, on west side of road. Ground elevation, 2,513 feet (t); depth to water, 32.9 feet, October 20, 1941.		
142. Southeast corner of NE $\frac{1}{4}$ Sec. 36, T.3 N., R.30 W.; approximately on east center line, 100 feet north of river bridge, on west side of road. Ground elevation, 2,481 feet (t); depth to water, 7.5 feet, October 20, 1941.			SOIL, sandy, dark brown	8	8
ROAD FILL and dark brown sandy soil	3	3	CLAY, sandy, buff tan	28	36
SAND, fine, red, to fine red gravel	20	23	GRAVEL, medium to coarse, red	7	43
SAND, very fine, red	6	29	GRAVEL, medium to coarse, green	5	48
GRAVEL, medium to coarse, red	4	33	GRAVEL, medium to coarse, gray	10	58
SAND, very fine, red	5	38	CLAY, sandy, bluish gray	1	59
SHALE, dark gray	7	45	SAND, very fine, gray; streaks of bluish gray clay	30	89
143. Northeast corner of NE $\frac{1}{4}$ Sec. 1, T.2 N., R.30 W.; 100 feet south of corner, on west side of road. Ground elevation, 2,485 feet (t); depth to water, 8.1 feet, October 20, 1941.			GRAVEL, medium to coarse, gray; some clay	2	91
			SHALE, medium gray to dark	4	95
			147. Southeast corner of NE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 13, T.2 N., R.30 W.; 0.24 mile south of north section line, on west side of road. Ground elevation, 2,520 feet (t); depth to water, 23.6 feet, October 20, 1941.		
			ROAD FILL and black sandy soil	7	7

	Thick- ness (feet)	Depth (feet)
CLAY, sandy, buff tan - - - - -	14	21
CLAY, sandy, black - - - - -	11	32
CLAY, sandy, light yellowish gray -	8	40
CLAY, sandy, bluish gray - - - - -	37	77
GRAVEL, medium to coarse, green - -	6	83
SHALE, medium gray - - - - -	6	89

148. SW $\frac{1}{4}$ Sec. 13, T.2 N., R.30 W.; 0.15 mile east of southwest corner of section, on north edge of road. Ground elevation, 2,640 feet (t); depth to water, caved at 78.5 feet, September 23, 1941.

ROAD FILL and buff silt (Peorian) -	39	39
SILT, reddish buff - - - - -	9	48
CLAY, silty to sandy, limy, reddish buff - - - - -	6	54
SAND, clayey, reddish buff; limy concretions - - - - -	5	59
SILT, very limy, to sandy clay, white; hard, limy concretions - -	5	64
SAND, clayey, pale greenish; upper part sandstone - - - - -	4	68
SANDSTONE, hard, light tannish gray	6	74
GRAVEL, medium, well-sorted; clear quartz gravel - - - - -	6	80
SANDSTONE, light brown - - - - -	4	84
SAND, clayey, pale green; cuts like sandstone - - - - -	4	88
SAND, or sandstone, clayey, light tan	2	90
SANDSTONE, tan; cuts in small fragments - - - - -	3	93
SAND, silty to clayey, soft, tan -	3	96
SAND, clayey, light tan; hard, small chips - - - - -	2	98
CLAY, sandy, light tan; indurated, hard, fine grained, cuts small chips	5	103
CLAY, sandy, light tan to dark tan; indurated, hard, fine grained, more sand after 105 feet - - - - -	5	108
GRAVEL, fine to coarse, clear quartz, red, green grains, some brown - -	6	114
SHALE, tough, light gray stained rusty colored; cuts easily (Pierre)	28	142
SHALE, gray to dark bluish black; tough, rubbery (Pierre), some bentonite from 114 to 160 feet -	18	160

149. Northwest corner of NW $\frac{1}{4}$ Sec. 15, T.2 N., R.30 W.; 40 feet south of north line, 100 feet east of west line, on south side of road. Ground elevation, 2,538 feet (a); depth to water, 26.4 feet, October 27, 1941.

SOIL, sandy, black to dark brown -	7	7
CLAY, sandy, tan to grayish tan - -	41	48
GRAVEL, medium to coarse, red; dirty	3	51
GRAVEL, medium to coarse, green; fairly clean - - - - -	3	54
CLAY, sandy, blue - - - - -	9	66
GRAVEL, fine, red; dirty, some gray clay - - - - -	1	67
GRAVEL, medium to very coarse, gray; some gray clay at top - - - - -	6	73
GRAVEL, fine to medium, gray - - -	4	77
SHALE, medium, gray - - - - -	2	79

150. Sec. 17, T.2 N., R.30 W.; about on center line of section, 100 feet south of creek bridge, on west side of road. Ground elevation, 2,538 feet (a); depth to water, 19.8 feet, October 27, 1941.

ROAD FILL and brown sandy soil - -	8	8
CLAY, sandy, tan - - - - -	10	18
CLAY, sandy, brown - - - - -	8	26
GRAVEL, fine to medium, red - - - -	2	28
CLAY, sandy, gray - - - - -	13	41
SAND, very fine, red - - - - -	2	43
GRAVEL, medium to coarse, green - -	9	52
SAND, fine, gray - - - - -	2	54
GRAVEL, medium to coarse, gray - -	4	58
SHALE, medium gray to black - - - -	1	59

151. NE $\frac{1}{4}$ Sec. 19, T.2 N., R.30 W.; 300 feet south-east of east steel bridge, 12 feet north of center of road. Ground elevation, 2,558 feet (a); depth to water, 32.7 feet, September 19, 1942.

LOAM, sandy, and silt - - - - -	6	6
CLAY, sandy, yellow - - - - -	10	16
CLAY, yellow - - - - -	40	56
CLAY, yellow, and sand - - - - -	9	65
GRAVEL, fine to medium; lime and clay - - - - -	2	67
SHALE, dark - - - - -	7	74

GROUND-WATER MAP REPUBLICAN VALLEY REGION AND VICINITY FRONTIER COUNTY, NEBRASKA

LEGEND

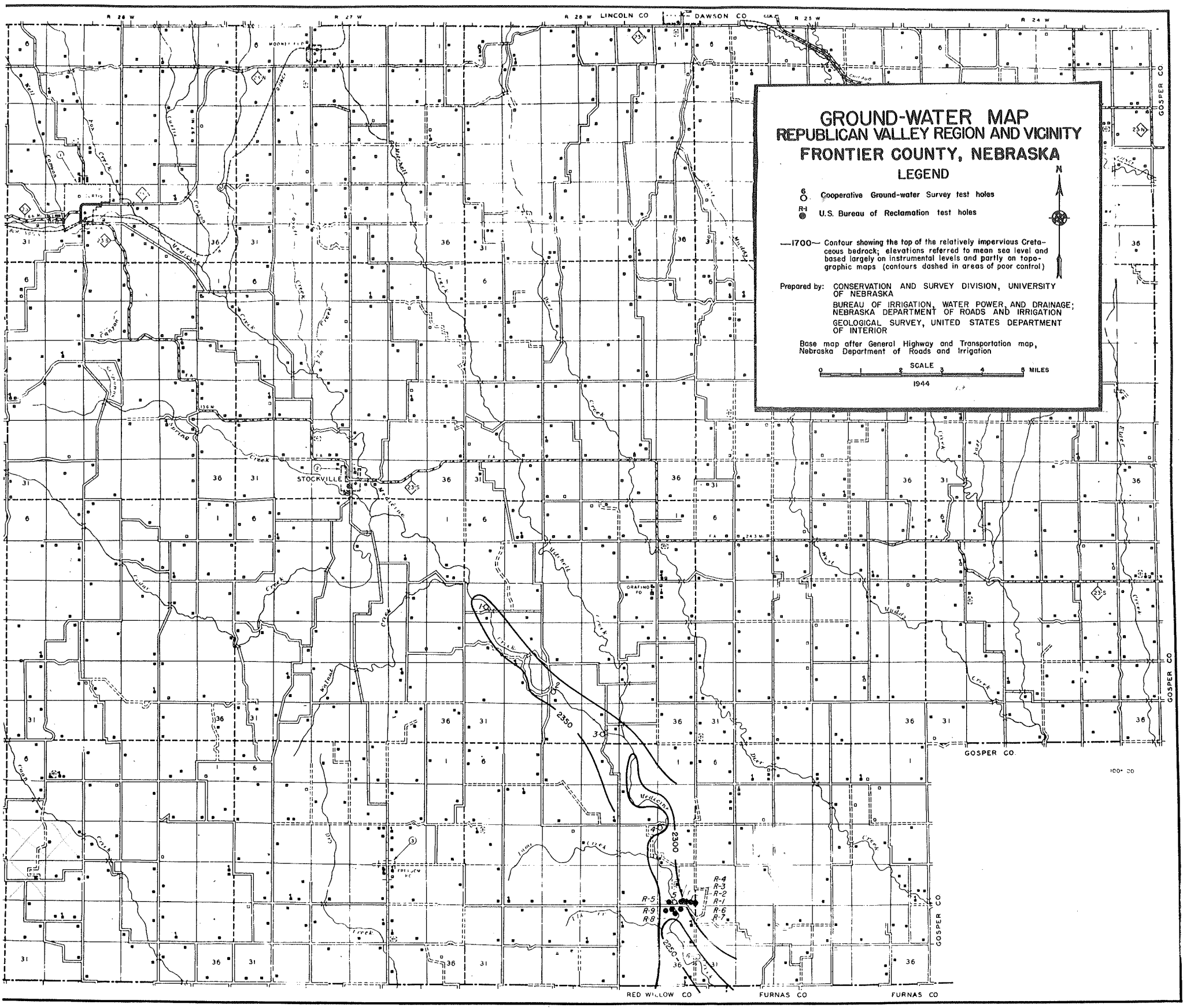
- Cooperative Ground-water Survey test holes
- U.S. Bureau of Reclamation test holes

—1700— Contour showing the top of the relatively impervious Cretaceous bedrock; elevations referred to mean sea level and based largely on instrumental levels and partly on topographic maps (contours dashed in areas of poor control)

Prepared by: CONSERVATION AND SURVEY DIVISION, UNIVERSITY OF NEBRASKA
BUREAU OF IRRIGATION, WATER POWER AND DRAINAGE;
NEBRASKA DEPARTMENT OF ROADS AND IRRIGATION
GEOLOGICAL SURVEY, UNITED STATES DEPARTMENT OF INTERIOR

Base map after General Highway and Transportation map, Nebraska Department of Roads and Irrigation

SCALE
0 1 2 3 4 5 MILES
1944



GROUND-WATER CONDITIONS IN FRONTIER COUNTY

The test-drilling program in Frontier County covered only a very small part of the southeastern quarter of the county and was confined to the Medicine Creek Valley from a point about 3.5 miles below Stockville south-eastward to the Frontier-Red Willow-Furnas county line.

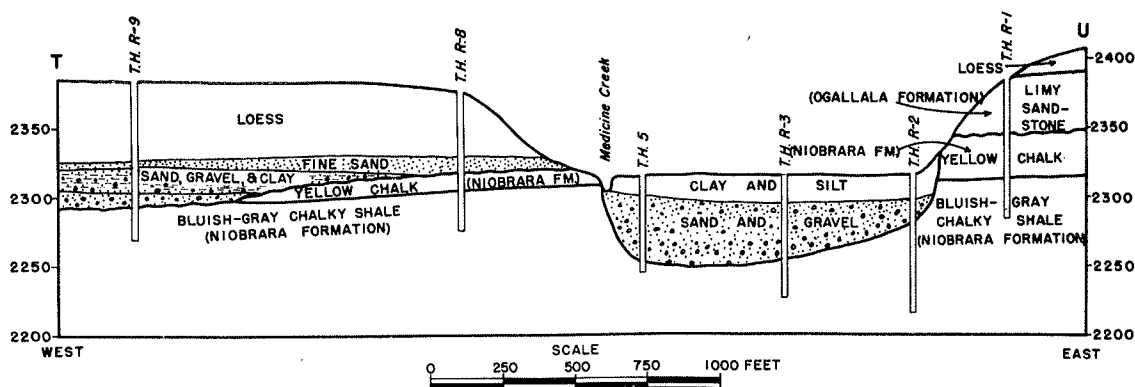
The bottomland and terrace region along the Medicine Creek Valley in Frontier County is characterized by the presence of deposits of sand and gravel that comprise the alluvium of the Valley. This part of the Medicine Creek Valley is quite similar hydrologically to that part of its course which lies in Furnas County. Ground-water conditions in the vicinity of this stream have been shown in geologic profile section T-U. The contours on the top of the relatively impervious Cretaceous bedrock show that a narrow buried channel, trending south-eastward, is present, and that this channel coincides with the present course of Medicine Creek in Frontier County.

In Medicine Creek valley deposits of sand and gravel comprising the alluvium were encountered in test holes 5, R-2 and R-3 (Geologic Profile Section T-U). On the west side of the valley the intermediate slopes are underlain by a thin deposit of sand and gravel which in turn rests upon yellow chalk and bluish-gray chalky shale of the Niobrara formation of Upper Cretaceous age. The sand and gravel deposits are capped by a comparatively thick mantle of loess. The Ogallala formation is

absent on the west side of the Valley, but on the east side the limy sandstone of the Ogallala formation overlies the yellow chalk of the Niobrara formation. The deposits of unconsolidated sand and gravel are absent on the east side of the Valley. The intermediate slopes and adjoining uplands on both sides of the Valley are capped by loess.

Geologic Profile Section T-U is based chiefly on the logs of 5 test holes (R-1, R-2, R-3, R-8, and R-9) that were drilled by the Bureau of Reclamation. The position of the water table has not been shown, because of insufficient water-level data. The water table in Medicine Creek Valley is at a comparatively shallow depth, and as a result favorable conditions prevail for the infiltration of a part of the precipitation that falls in the region, because the clay bed overlying the more permeable sands and gravels is, in most places, comparatively thin. There is also a possibility that during periods of stream flow some recharge takes place to the adjoining zone of saturation. There are good possibilities of developing small water supplies in places along Medicine Creek Valley where there is sufficient thickness of underlying saturated water-bearing material.

Conditions in the Medicine Creek Valley in Frontier County are shown in the following Geologic Profile Section:



This section is located 2 miles north of the Frontier-Red Willow county line and extends in an east-west direction from a point about 1,900 feet west of Medicine Creek (T) to a point about 1,700 feet east of the creek (U). Note the thin deposit of sand and gravel overlying the Niobrara formation on the west side of the valley of Medicine Creek, and the absence of similar deposits on the east side; the relatively good infiltration area in the valley in the vicinity of test holes R-2, R-3, and 5; the relatively high chalk bedrock (Niobrara formation) on both sides of the valley; the presence of limy sandstone and silt of the Ogallala formation (Tertiary age) overlying the chalk bedrock on the east side of the valley only; and the relatively thick mantle of loess capping the slopes both east and west of Medicine Creek. The chalky shale is part of the Niobrara formation of Upper Cretaceous age. In general, the Niobrara formation is relatively impervious and does not provide a dependable source of water for this area.

LOGS OF TEST HOLES DRILLED IN FRONTIER COUNTY
BY THE UNITED STATES BUREAU OF RECLAMATION

18 FT 44

✓ 1-R. SE $\frac{1}{4}$ Sec. 24, T.5 N., R.26 W.; 400 feet north and 3,800 feet east of southwest corner of section. Ground elevation, 2,384 feet (i); depth to water, not measured.

LIME, chalky, white	40	40
CHALK, yellow	30	70
SHALE, blue	30	100

✓ 2-R. SE $\frac{1}{4}$ Sec. 24, T.5 N., R.26 W.; 400 feet north and 3,400 feet east of southwest corner of section. Ground elevation, 2,316 feet (i); depth to water, not measured.

TOP SOIL	4	4
SILT	6	10
SILT and lime pebbles	7	17
SAND and gravel, coarse	7	24
SILT and small lime pebbles	9	33
SHALE, blue	67	100

✓ 3-R. SE $\frac{1}{4}$ Sec. 24, T.5 N., R.26 W.; 200 feet north and 3,000 feet east of southwest corner of section. Ground elevation, 2,315 feet (i); depth to water, not measured.

TOP SOIL and silt	10	10
SILT, sandy, fine	10	20
SAND, coarse	40	60
SHALE, blue	28	88

✓ 4-R. SE $\frac{1}{4}$ Sec. 24, T.5 N., R.26 W.; 250 feet north and 2,750 feet east of southwest corner of section. Ground elevation, 2,314 feet (i); depth to water, not measured.

TOP SOIL	5	5
SAND, silty, fine	12	17
SAND and gravel	45	62
SHALE, blue	25	87

✓ 5-R. SW $\frac{1}{4}$ Sec. 24, T.5 N., R.26 W.; 2,000 feet east of southwest corner. Ground elevation, 2,314 feet (i); depth to water, not measured.

TOP SOIL and clay	10	10
SILT, fine, sandy	5	15
SAND	3	18
SAND and gravel	2	20
SHALE, blue	25	45

6 R FT 44

✓ 6-R. NE $\frac{1}{4}$ Sec. 25, T.5 N., R.26 W.; 200 feet south and 3,000 feet east of northwest corner of section. Ground elevation, 2,313 feet (i); depth to water, not measured.

TOP SOIL and silt	8	8
SAND	7	15
SAND, coarse	5	20
SAND, fine, silty	5	25
SAND and gravel	35	60
SHALE, blue	30	90

✓ 7-R. NW $\frac{1}{4}$ Sec. 25, T.5 N., R.26 W.; 600 feet south and 2,500 feet east of northwest corner. Ground elevation, 2,335 feet (i); depth to water, not measured.

TOP SOIL and silty clay	10	10
SILT, black	5	15
CLAY, silty, yellow	15	30
SAND, fine	5	35
SAND and gravel	5	40
SAND, coarse	4	44
SHALE, blue	26	70

✓ 8-R. NW $\frac{1}{4}$ Sec. 25, T.5 N., R.26 W.; 400 feet south and 2,100 feet east of northwest corner. Ground elevation, 2,376 feet (i); depth to water, not measured.

TOP SOIL and yellow clay	10	10
CLAY, yellow	37	47
SAND, fine	10	57
SHALE, yellow	5	62
SHALE, brown	8	70
SHALE, blue	30	100

✓ 9-R. NW $\frac{1}{4}$ Sec. 25, T.5 N., R.26 W.; 1,100 feet east and 900 feet south of northwest corner. Ground elevation, 2,384 feet (i); depth to water, not measured.

TOP SOIL and clay	10	10
CLAY, yellow	47	57
SAND, fine	3	60
GRAVEL and clay, coarse	20	80
SAND and gravel	10	90
SHALE, blue	25	115

(t) Elevations estimated from topographic map.
(a) Elevations obtained by altimeter levels.

(i) Elevations established by instrumental levels.

LOGS OF TEST HOLES DRILLED IN FRONTIER COUNTY
BY THE CONSERVATION AND SURVEY DIVISION,
THE BUREAU OF IRRIGATION AND THE FEDERAL GEOLOGICAL SURVEY

1. NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 18, T.6 N., R.26 W.; 100 feet west of creek on north side of road. Ground elevation, 2,389 feet (i); depth to water, not measured, December 24, 1942.

CLAY, sandy - - - - -	3	3
CLAY, sandy, dark - - - - -	9	12
SAND and fine to medium gravel - -	10	22
SAND and fine to medium gravel; some lime - - - - -	20	42
GRAVEL and shale - - - - -	3	45
SHALE, very hard, brown - - - - -	10	55

2. SW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 28, T.6 N., R.26 W.; 33 feet east of bridge across draw. Ground elevation, 2,372 feet (i); depth to water, not measured, December 24, 1942.

CLAY, sandy, yellow - - - - -	5	5
CLAY, sandy, dark - - - - -	11	16
GRAVEL and clay, light - - - - -	10	26
SAND and fine to medium gravel - -	11	37
SHALE, very hard, brown - - - - -	6	43

3. NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 34, T.6 N., R.26 W.; south of bridge site, on west side of trail. Ground elevation, 2,356 feet (i); depth to water, not measured, December 23, 1942.

CLAY, sandy, yellow - - - - -	4	4
CLAY, sandy, dark - - - - -	7	11
SAND and fine to medium gravel - -	11	22
SAND and fine to medium gravel; some sandrock - - - - -	10	32
SAND and fine to medium gravel; some sandrock and clay - - - - -	10	42
GRAVEL and dark clay - - - - -	9	51
GRAVEL, fine - - - - -	3	54
SHALE, dark - - - - -	5	59

✓ 4. Northeast corner of Sec. 14, T.5 N., R.26 W. Ground elevation, 2,381 feet (i); depth to water, not measured, December 23, 1942.

CLAY, sandy, yellow - - - - -	4	4
CLAY, sandy, dark - - - - -	8	12
CLAY, yellow - - - - -	20	32
CLAY, hard, yellow - - - - -	10	42
SAND and fine to medium gravel; some clay - - - - -	11	53
SAND and fine gravel - - - - -	10	63
GRAVEL, fine, and hard clay - - - -	6	69
SHALE, light, very solid - - - - -	10	79

✓ 5. SW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 24, T.5 N., R.26 W.; on south section line, about 300 feet east of creek. Ground elevation, 2,315 feet (i); depth to water, not measured, December 22, 1942.

CLAY, sandy, yellow - - - - -	5	5
CLAY, sandy, dark - - - - -	9	14
SAND and fine to medium gravel, red; some lime - - - - -	10	24
GRAVEL, fine, medium, coarse, blue	10	34
GRAVEL, fine to medium, blue - - -	10	44
GRAVEL, fine to medium, blue and red	10	54
SAND and fine gravel - - - - -	8	62
SHALE, dark - - - - -	7	69

✓ 6. SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 31, T.5 N., R.25 W.; 0.3 mile south of north section line, 250 feet north of bridge, on east side of road. Ground elevation, 2,304 feet (i); depth to water, not measured, December 22, 1942.

SAND, yellow - - - - -	8	8
GRAVEL, fine, medium, coarse, red; some lime - - - - -	20	28
GRAVEL, fine, medium, coarse, blue	10	38
SAND and fine gravel, blue - - - -	10	48
GRAVEL, fine, medium, coarse, blue	10	58
SAND and fine gravel, blue - - - -	5	63
SHALE, dark - - - - -	6	69

(t) Elevations estimated from topographic map.
(a) Elevations obtained by altimeter levels.

(i) Elevations established by instrumental levels.